Agilent 1200 Series Binary Pump SL

User Manual

Agilent Technologies

Notices

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WARNING

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1 Introduction to the Binary Pump SL

This chapter provides an overview of the functionality of the Binary Pump SL.

2 Site Requirements and Specifications

This chapter provides information about site requirements and specifications for the Binary Pump SL.

3 Installing the Pump

This chapter gives information about the preferred stack setup for your system and the installation of your Binary Pump SL.

4 Using the Pump

This chapter explains the operational parameters of the Binary Pump SL.

5 Optimizing Performance

This chapter gives information on how to optimize the performance of the Binary Pump SL under special operational conditions.

6 Tests and Calibration Functions

This chapter explains all test functions that are available for the Binary Pump SL.

7 Maintenance and Repair

This chapter provides general information on repairing the Binary Pump SL.

8 Maintenance and Simple Repairs

This chapter describes all maintenance and simple repair procedures that can be performed without removing the pump from the system stack.

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1 Introduction to the Binary Pump SL

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This chapter provides an overview of the functionality of the Binary Pump SL.

Introduction to the Binary Pump SL

The Binary Pump SL comprises two identical pumps integrated into one housing. Binary gradients are created by high-pressure mixing. An optional degasser is available for applications that require best flow stability, especially at low flow rates, for maximum detector sensitivity. Pulse damper and mixer can be bypassed for low flowrate applications or whenever a minimal transient volume is desirable. Typical applications are high throughput methods with fast gradients on high resolution 2.1 mm columns. The pump is capable of delivering flow in the range of 0.1 - 5 mL/min against up to 600 bar. A solvent selection valve (optional) allows to form binary mixtures (isocratic or gradient) from one of two solvents per channel. Active seal wash (optional) is available for use with concentrated buffer solutions.

Instrument Layout

The industrial design of the module incorporates several innovative features. It uses Agilent's E-PAC concept for the packaging of electronics and mechanical assemblies. This concept is based upon the use of expanded polypropylene (EPP) foam plastic spacers in which the mechanical and electronic boards components of the module are placed. This pack is then housed in a metal inner cabinet which is enclosed by a plastic external cabinet. The advantages of this packaging technology are:

- virtual elimination of fixing screws, bolts or ties, reducing the number of components and increasing the speed of assembly/disassembly,
- the plastic layers have air channels molded into them so that cooling air can be guided exactly to the required locations,
- the plastic layers help cushion the electronic and mechanical parts from physical shock, and

the metal inner cabinet shields the internal electronics from electromagnetic interference and also helps to reduce or eliminate radio frequency emissions from the instrument itself.

Principle of Operation

The Binary Pump SL is based on a two-channel, dual-piston in-series design which comprises all essential functions that a solvent delivery system has to fulfill. Metering of solvent and delivery to the high-pressure side are performed by two pump assemblies which can generate pressure up to 600 bar.

Each channel comprises a pump assembly including pump drive, pump head, active inlet valve with replaceable cartridge and outlet valve. The two channels are fed into a low-volume mixing chamber which is connected via a restriction capillary coil to a damping unit and a mixer. A pressure sensor monitors the pump pressure. A purge valve with integrated PTFE frit is fitted to the pump outlet for convenient priming of the pumping system.

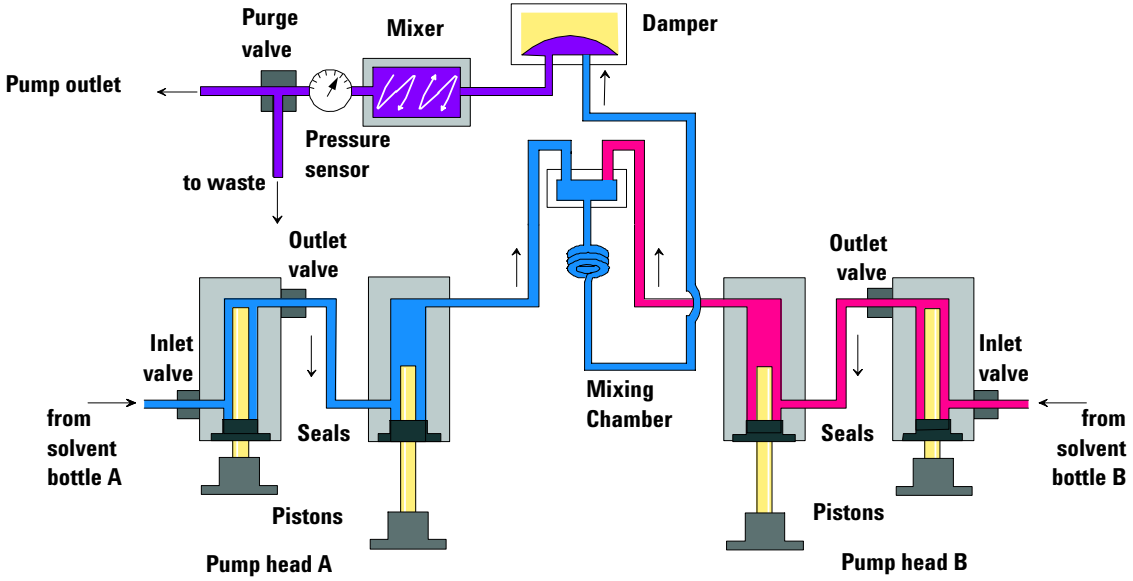

Figure 1 The Hydraulic Path of the Binary Pump SL with Damper and Mixer

Damper and mixer can be bypassed for lowest delay volume of the Binary Pump SL. This configuration is recommended for low flow rate applications with steep gradients, see the Rapid Resolution System Manual.

Figure Figure 2 on page 14 illustrates the flow path in low delay volume mode. For instructions on how to change between the two configurations, see "Convert the Binary Pump SL to Low Delay Volume Mode" on page 76.

NOTE Bypassing the mixer while the damper remains in line is not a supported configuration and may lead to undesired behavior of the Binary Pump SL.

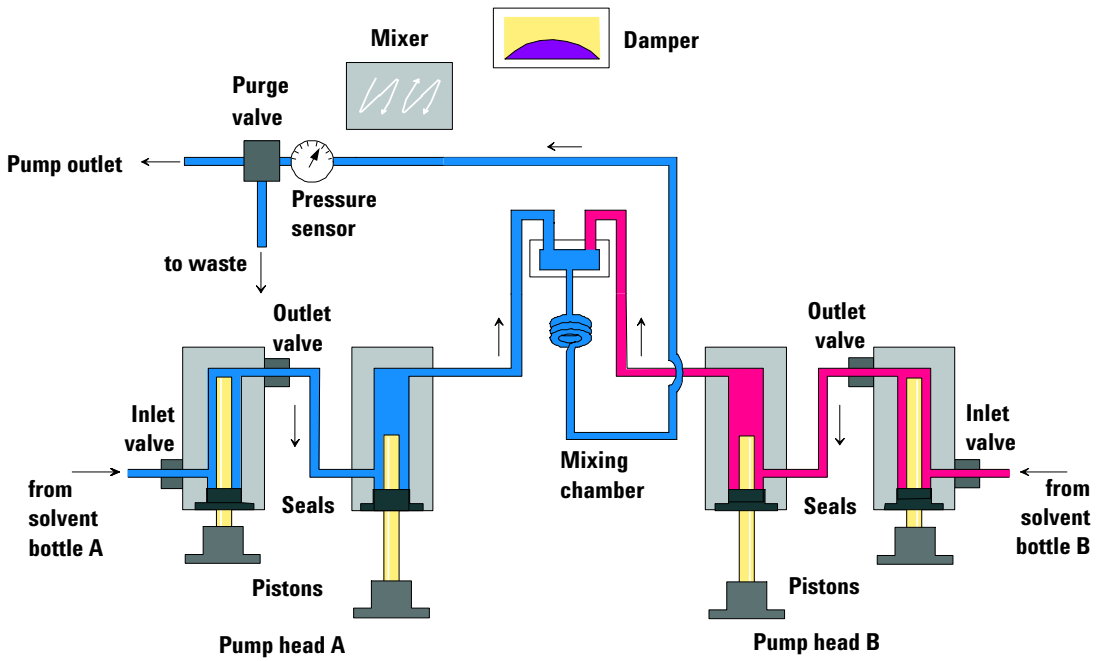

Figure 2 The Hydraulic Path of the Binary Pump SL with bypassed Damper and Mixer

Table 1 Binary Pump SL Details

Delay volume	From mixing point to pump outlet, dependent on back pressure 120 µL without damper and mixer 600 – 800 µL with damper and mixer
Materials in contact with mobile phase	

Table 1 Binary Pump SL Details, continued

Pump head	SST, gold, sapphire, ceramic
Active Inlet Valve	SST, sapphire, ruby, ceramic, PTFE
Outlet Valve	SST, gold, sapphire, ruby, tantalum
Adapter	SST, gold
Purge Valve	SST, gold, PTFE, ceramic
Damping Unit	Gold, SST

For pump specifications, see Chapter 2, “Site Requirements and Specifications”.

Optimization Features

What is Pump Elasticity Compensation?

The flow path of the pump consists of pump chambers, sapphire pistons, polymer seals, stainless steel tubing of different dimension, pressure sensor, and so forth. All of these parts deform when pressurized. The sum of this deformation is called pump elasticity. The performance of the pump is greatly enhanced by correcting for this elasticity.

The *Pump Elasticity Calibration* calculates correction factors to compensate for the individual elasticity of the pump that was calibrated.
The elasticity is different for every pump and may change with the replacement of parts in the flow path, e.g. pump seals.

All Binary Pumps SL are elasticity calibrated at the factory and require recalibration only after preventive maintenance or major repairs to the flow path. Replacement of capillaries or PTFE frits are not considered a major repair.

What is Solvent Compressibility Compensation?

Although the compressibility of liquids is orders of magnitude lower then the compressibility of gases, a noticeable volume error is seen when typical chromatographic solvents are compressed to operating pressures as high as

600 bar. In addition, the compressibility changes with pressure, temperature and the amount of dissolved gas. In order to minimize the influence of the latter, the use of a vacuum degasser is mandatory for high precision delivery of liquids. Unfortunately, the influence of the temperature on compressibility is non-linear and cannot be calculated.

The Agilent Binary Pump SL features a new multi point compressibility calibration. The compressibility of a solvent is determined at different pressures from 0 - 600 bar and stored in an XML file. This file can be distributed to other pumps because the solvent compressibility is independent from the pump.

The Binary Pump SL and ChemStation come with predetermined solvent compressibility data for the most common HPLC solvents like water, acetonitrile, methanol, etc. Users can calibrate their own solvent mixtures with the help of an easy to use calibration procedure in the Agilent LC Diagnostic software.

CAUTION

A correct pump elasticity calibration is an essential prerequisite for successful solvent compressibility calibrations!

Solvent compressibility calibrations acquired with a miscalibrated pump will work, but they are not transferable to other pumps!

How Does Variable Stroke Volume Work?

The smaller the solvent volume in the pump chamber is, the faster it can be recompressed to operating pressure. The Binary Pump SL allows to manually or automatically adjust the pump stroke volume of the first piston in the range of 20 - 100 µL. Due to the compression of the solvent volume in the first pump chamber, each piston stroke of the pump will generate a small pressure pulsation, influencing the flow ripple of the pump. The amplitude of the pressure pulsation is mainly dependent on the stroke volume and the compressibility compensation for the solvent in use. Small stroke volumes generate less pressure pulsation than larger stroke volumes at the same flow rate. In addition, the frequency of the pressure pulsation will be higher. This will decrease the influence of flow pulsations on quantitative results.

In gradient mode, smaller stroke volume results in less flow ripple and improves the composition ripple.

The Binary Pump SL uses a processor-controlled ball screw system to drive its pistons. The normal stroke volume is optimized for the selected flow rate. Small flow rates use a small stroke volume while higher flow rates use a higher stroke volume.

The stroke volume for the pump is by default set to AUTO mode. This means that the stroke is optimized for the flow rate in use. A change to larger stroke volumes is possible but not recommended.

Electrical Connections

- The CAN bus is a serial bus with high-speed data transfer. The two connectors for the CAN bus are used for internal Agilent 1200 Series module data transfer and synchronization.
- One analog output provides a pressure signal for integrators or data handling systems.
- The REMOTE connector may be used in combination with other non 1100/1200 Series equipment if you want to use features such as common shut down, prepare, and so on.
- The RS-232 connector may be used to control the Binary Pump SL from a computer via RS-232 connection, using appropriate software. This connector needs to be activated by the configuration switch module at the rear of the pump. The software needs the appropriate drivers to support this communication. See your software documentation for further information.
- The power input socket accepts a line voltage of 100 – 120 or 220 – 240 volts AC ± 10 % with a line frequency of 50 or 60 Hz. Maximum power consumption is 220 VA (Volt-Amps). There is no voltage selector on your Binary Pump SL because the power supply has wide-ranging capability. There are no externally accessible fuses, because automatic electronic fuses are implemented in the power supply. The security lever at the power input socket prevents that the Binary Pump SL cover is taken off when line power is still connected.
- The interface board slot is used for external contacts, BCD output or the installation of a G1369A LAN interface.

WARNING **Never use cables other than the ones supplied by Agilent Technologies to ensure proper functionality and compliance with safety or EMC regulations.**

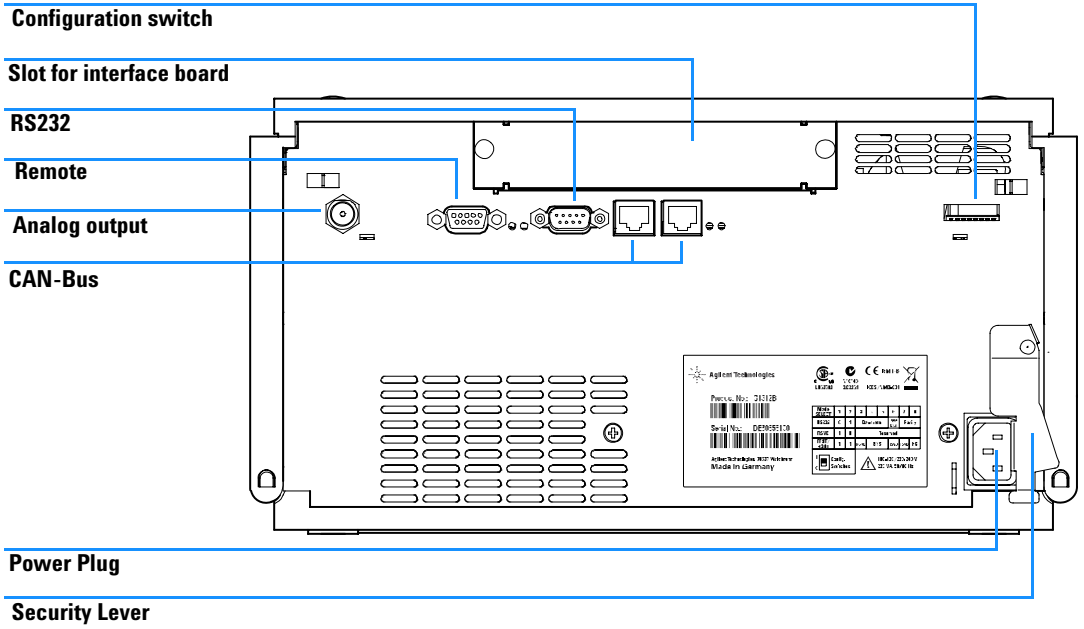

Figure 3 Electrical Connections to the Binary Pump SL

WARNING **To disconnect the binary pump from line, unplug the power cord. The power supply still uses some power, even if the power switch on the front panel is turned off.**

Interfaces

The Binary Pump SL provides the following interfaces:

- two CAN connectors as interface to other Agilent 1200 Series modules,
- one RS-232C as interface to a computer,
- one REMOTE connector as interface to other Agilent products,
- one analog output for pressure signal output, and
- one slot for optional interface boards

Firmware Updates

Firmware updates can be done using your user interface:

- G4208A Instant Pilot with files from a USB-stick
- Agilent ChemStation with files from CD-ROM

The file naming conventions are:

1312B_A601_12.dlb, or more general:

xxxxx_yyyy_zz.dlb, where

xxxx	is the product number, e.g. 1316 for the G1316A TCC, and
yyyy	is the revision number, for example A601 is revision A.06.01, and
zz	is the build number

For instructions refer to your user interface.

NOTE

Update of main system can be done in the resident system only.

Update of the resident system can be done in the main system only.

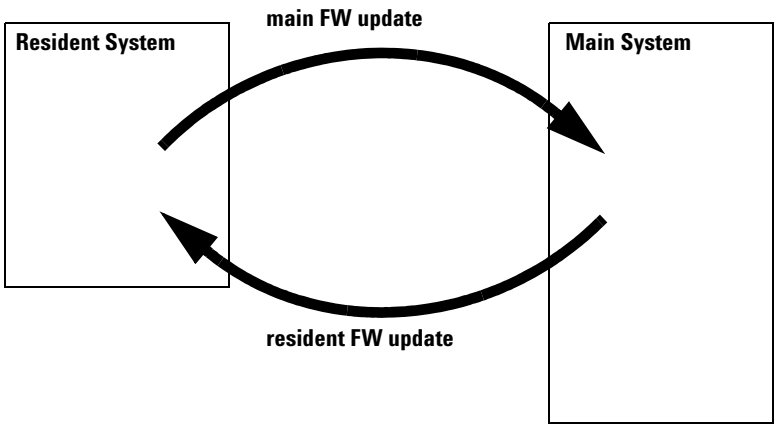

Figure 4 Firmware Update Mechanism

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Site Requirements and Specifications

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This chapter provides information about site requirements and specifications for the Binary Pump SL.

Site Requirements

A suitable environment is important to ensure optimal performance of the pump.

Power Considerations

The power supply of the pump has wide ranging capabilities and accepts any line voltage in the range mentioned in Table 2. Consequently, there is no voltage selector at the back of the instrument. There are also no externally accessible fuses, as automatic electronic fuses are implemented in the power supply.

WARNING **To disconnect the pump completely from line power, unplug the power cord. The power supply still uses some power, even if the power switch on the front panel is turned off.**

WARNING **Shock hazard or damage of your instrumentation can result if the devices are connected to line voltage higher than specified.**

CAUTION Make sure to have easy access to the power cable of the instrument in order to disconnect the instrument from line.

Power Cords

Different power cords are offered as options with the pump. The female end of all power cords is identical. It plugs into the power-input socket at the back of the pump. The male end of each power cord is different and designed to match the wall socket of a particular country or region.

WARNING **Never operate your instrumentation from a power outlet that has no ground connection. Never use a power cord other than the Agilent Technologies power cord designed for your region.**

WARNING **Never use cables other than the ones supplied by Agilent Technologies to ensure proper functionality and compliance with safety or EMC regulations.**

Bench Space

The pump dimensions and weight (see Table 2) allow you to place the module on almost any table or laboratory bench. It needs additional 2.5 cm (1.0 inches) of space on either side and approximately 8 cm (3.1 inches) in the rear for air circulation and electric connections.

Should the bench carry a Agilent 1200 Series system, be sure it is designed to bear the weight of all modules.

The pump must be operated horizontal position.

Environment

Your pump will work within the specifications at ambient temperature and relative humidity described in Table 2.

CAUTION Do not store, ship or use your pump under conditions where temperature fluctuations could cause condensation within the pump. Condensation will damage the system electronics. If your pump has been shipped in cold weather, leave it in its box and allow it to warm up to room temperature slowly to avoid condensation.

NOTE The G1312B pump is designed to operate in a typical electromagnetic environment (EN61326-1) where RF transmitters, such as mobile phones, should not be used in close proximity.

Physical Specifications

Table 2 Physical Specifications

Type	Specification	Comments
Weight	15.5 kg (34 lbs)	
Dimensions (width × depth × height)	180 × 345 × 435 mm (7 × 13.5 × 17 inches)	
Line voltage	100 – 240 VAC, ± 10 %	Wide-ranging capability
Line frequency	50 or 60 Hz ± 5 %	
Power consumption (G1312B)	160 VA	Maximum
Ambient operating temperature	0 – 55 °C (32 – 131 °F)	.
Ambient non-operating temperature	-40 – 70 °C (-4 – 158 °F)	
Humidity	< 95%, at 25 – 40 °C (77 – 104 °F)	Non-condensing
Operating altitude	Up to 2000 m (6500 ft)	
Non-operating altitude	Up to 4600 m (14950 ft)	storage conditions
Safety standards: IEC, CSA, UL, EN	Installation category II, pollution degree 2	

Performance Specifications

Table 3 Performance Specifications of the Agilent 1200 Series Binary Pump SL

Type	Specification	Comments
Hydraulic system	Two dual piston in series pumps with proprietary servo-controlled variable stroke drive, floating piston design and active inlet valve	
Setable flow range	Stipends 0.001 – 5 mL/min, in 0.001 mL/min increments	
Flow range	0.05 – 5.0 mL/min	
Flow precision	≤0.07% RSD or ≤0.02 min SD, whatever is greater	based on retention time at constant room temperature
Flow accuracy	± 1% or 10 µL/min, what ever is greater	measured with water
Pressure	Operating range 0 – 600 bar (0 – 7800 psi) up to 5 ml/min	
Pressure pulsation	**Standard delay volume configuration:** < 2% amplitude (typically < 1%) **Low delay volume configuration:** < 5% amplitude (typically < 2%)	at 1 mL/min water, at all pressures > 1 MPa
Compressibility compensation	Automatic, pre-defined, based on mobile phase compressibility	
Recommended pH range	1.0 – 12.5	Solvents with pH < 2.3 should not contain acids which attack stainless steel.
Gradient formation	High-pressure binary mixing	
Delay volume	**Standard delay volume configuration:** 600-800 µl, dependent on back pressure (includes 400 µl mixer) **Low delay volume configuration:** 120 µl	measured with water

Table 3 Performance Specifications of the Agilent 1200 Series Binary Pump SL, continued

Type	Specification	Comments
Composition range	settable range: 0 – 100% recommended range: 1 – 99% or 5 µl/min per channel, whatever is greater	
Composition precision	< 0.15 % RSD	at 1mL/min
Composition accuracy	± 0.35% absolute	(water/caffeine tracer)
Control	Agilent ChemStation for LC (32-bit) G4208A Handheld Controller EZ Chrom Elite	Revision B.02.00 or above
Analog output	For pressure monitoring, 1.33 mV/bar, one output	
Communications	Controller-area network (CAN), RS-232C, APG Remote: ready, start, stop and shut-down signals, LAN optional	
Safety and maintenance	Extensive diagnostics, error detection and display (through Agilent LC Diagnostics), leak detection, safe leak handling, leak output signal for shutdown of pumping system. Low voltages in major maintenance areas.	
GLP features	Early maintenance feedback (EMF) for continuous tracking of instrument usage in terms of seal wear and volume of pumped mobile phase with pre-defined and user-settable limits and feedback messages. Electronic records of maintenance and errors.	
Housing	All materials recyclable.	

NOTE

For use with flow rates below 500 µl/min or for use without damper and mixer a vacuum degasser is required.

All specification measurements are done with degassed solvents.

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Installing the Pump

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This chapter gives information about the preferred stack setup for your system and the installation of your Binary Pump SL.

Unpacking the Binary Pump SL

Damaged Packaging

When you receive your Binary Pump SL inspect the shipping boxes for any signs of damage. If the containers or cushioning material are damaged, save them until the contents have been checked for completeness and the pump has been mechanically and electrically checked. If the shipping container or cushioning material is damaged, notify the carrier and save the shipping material for inspection by the carrier.

CAUTION If there are signs of damage to the pump, please do not attempt to install the instrument.

Delivery Checklist

Compare the delivery checklist with the contents of the shipping boxes to ensure completeness of the shipment. The contents lists is shown in Table 4. For parts identification check the illustrated parts breakdown in Chapter 9, “Parts and Materials for Maintenance”. Please report missing or damaged parts to your local Agilent Technologies sales and service office.

Table 4 Binary Pump SL Delivery Checklist

Description	Part Number	Quantity
Binary Pump SL		1
Calibration capillary assembly	G1312-67500	1
Agilent LC Diagnostic CD-ROM	G2173-64000	1
1200 Binary Pump SL Start up Kit	G1312-68700	1
Syringe adapter luer/barb	0100-1681	1
Syringe	9301-0411	1
Solvent cabinet (4 bottles, for pumps with solvent selection valve), **or** Solvent cabinet (2 bottles, for pumps without solvent selection valve)	5067-1531 5067-1532	1

Table 4 Binary Pump SL Delivery Checklist, continued

Description	Part Number	Quantity
Solvent bottle amber Solvent bottle transparent	9301-1450 9301-1420	1 1 **or** 3
Bottle head assembly	G1311-60003	2 **or** 4
1200 Binary Pump SL User Manual	G1312-90010	1
SB-C18, 2.1x50mm,1.8um,600bar, **or** SB-C18, 4.6x50mm, 1.8um, 600bar, **or** Eclipse XDB-C18, 4.6x50mm, 1.8um, 600bar	827700-902 827975-902 927975-902	1, **or** 1, **or** 1
Power cable (matching your country's power socket)		1
Accessory kit (see Table 11)	G131268725	1

Optimizing the Stack Configuration

If your Binary Pump SL is part of a complete Agilent 1200 series Rapid Resolution LC System, system performance can be optimized by stacking the instrument modules in either of the ways shown below.

Single Stack Setup

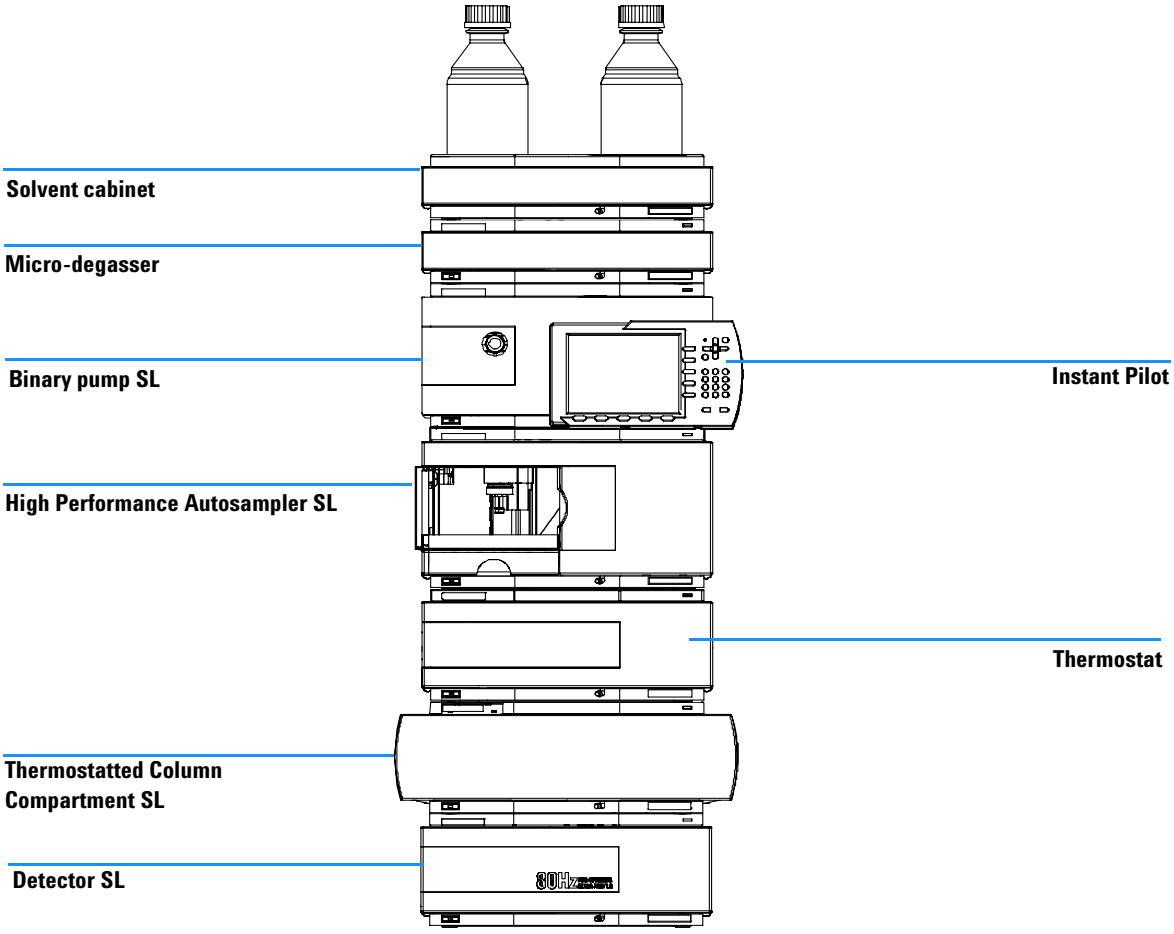

Figure 5 Recommended Single Stack Configuration (Front View)

NOTE For a detailed view of the flow connections refer to the section “Flow connections in the Rapid Resolution LC System manual.

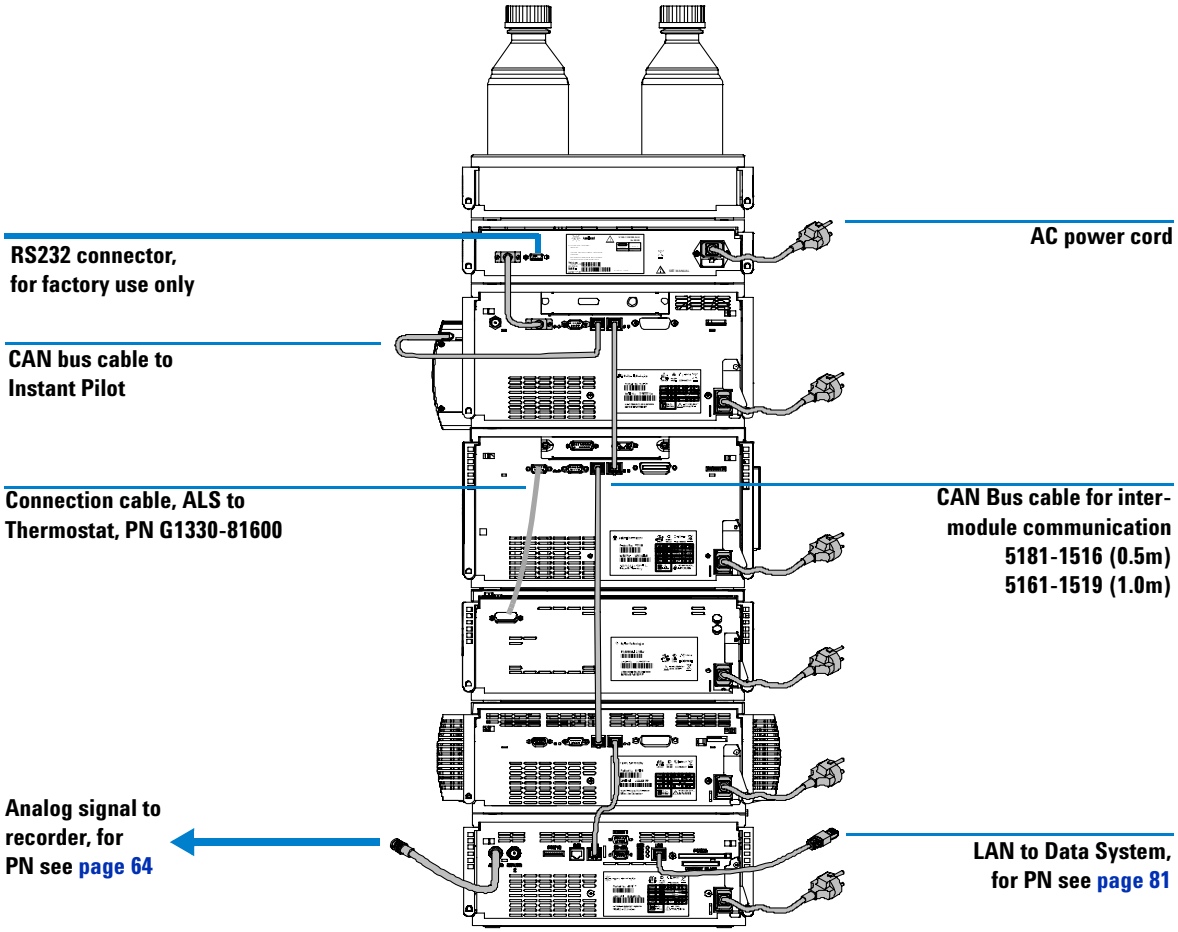

Figure 6 Recommended Single Stack Configuration (Rear View)

Twin Stack Setup

If a single stack configuration becomes too tall, e.g. if an additional module is added or if your bench is too high, a two stack setup should be considered. Split the stack between pump and sampler. Put the solvent cabinet, the degasser and the pump into the left stack and the rest of the modules into the right stack.

NOTE In order to optimize the flow path, the stacking order of the right stack is reversed. The sampler is located at the bottom and the detector is at the top.

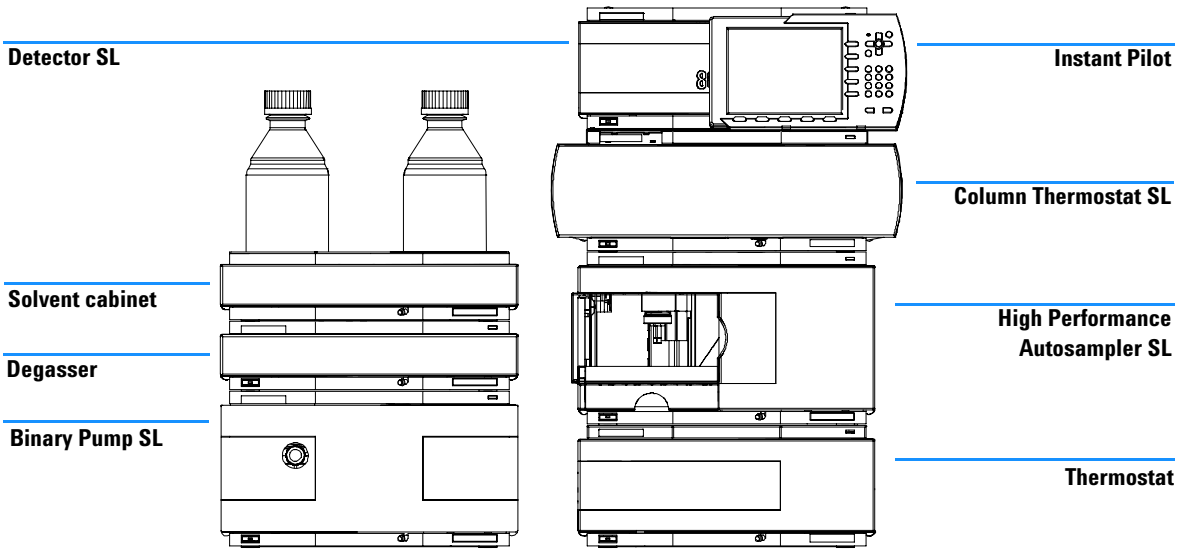

Figure 7 Recommended Twin Stack Configuration (Front View)

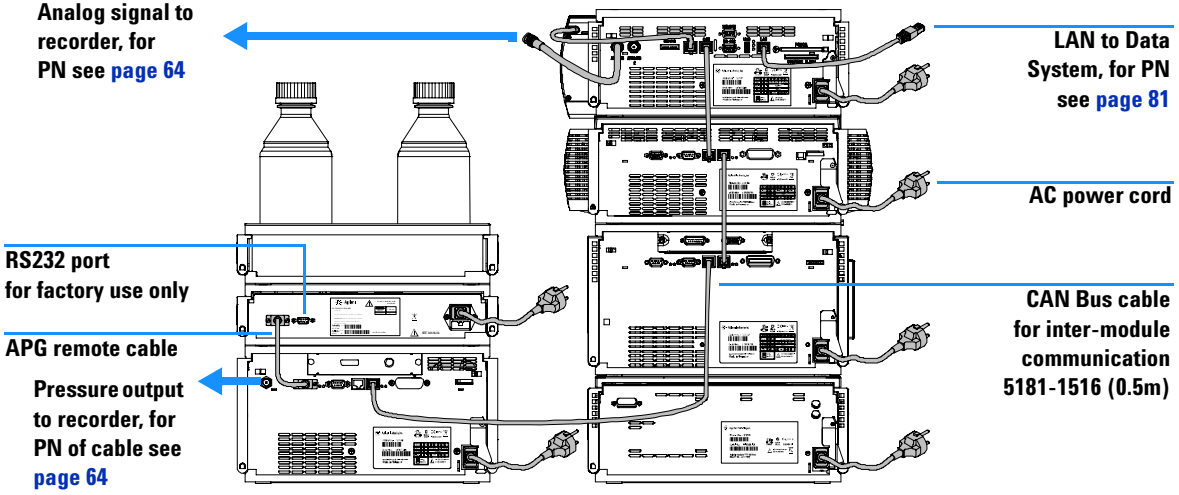
Analog signal to recorder, for PN see page 64
LAN to Data System, for PN see page 81
AC power cord
RS232 port for factory use only
APG remote cable
CAN Bus cable for inter-module communication 5181-1516 (0.5m)
Pressure output to recorder, for PN of cable see page 64

Figure 8 Recommended Twin Stack Configuration (Rear View)

Installing the Binary Pump SL

Preparations	Locate bench space Provide power connections Unpack the pump
Parts required	Pump Power cord, for other cables see text below and "Cable Overview" on page 62 Agilent Control Software and/or Instant Pilot G4208A

1 Place the Binary Pump SL horizontally on the bench.

2 Ensure the power switch on the front of the pump is OFF (switch stands out).

3 At the rear of the pump turn the security lever to expose the power inlet socket.

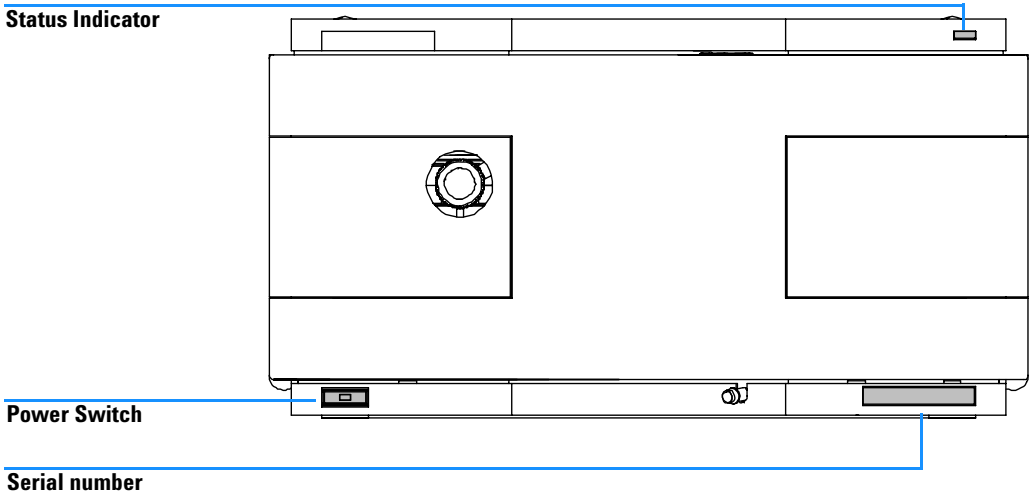

Figure 9 Front of Binary Pump SL

4 Connect the power cable to the power connector at the back of the Binary Pump SL. The security lever prevents that the cover is opened while the power cord is connected to the pump.

5 Connect the required interface cables to the rear of the Binary Pump SL.

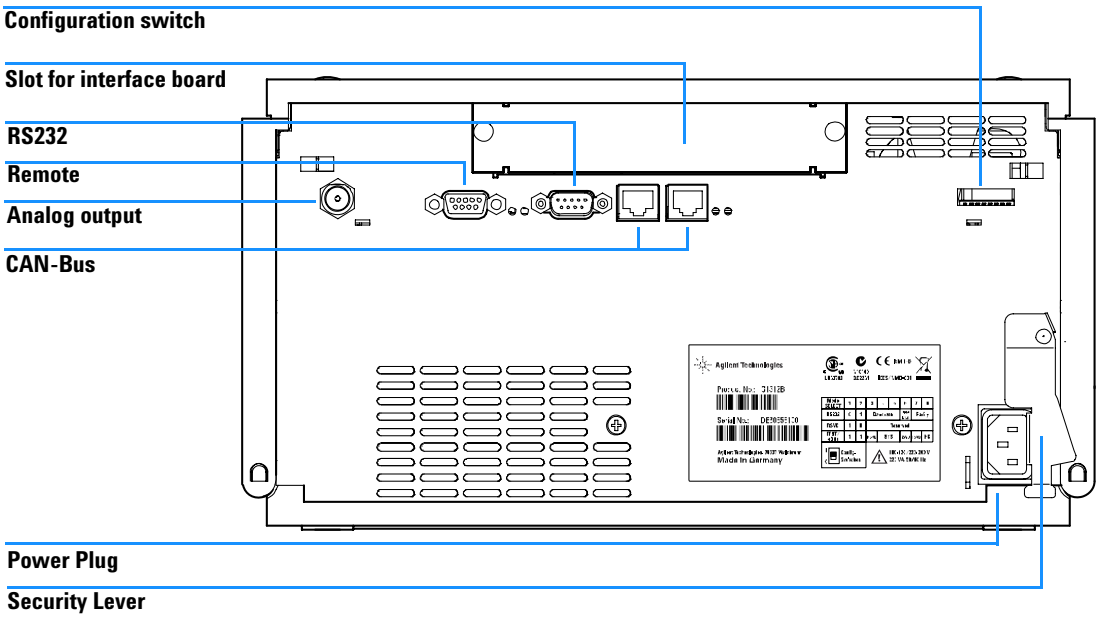

Figure 10 Rear of the Binary Pump SL

NOTE

In an Agilent 1200 Series system, the individual modules are connected through CAN cables. The Agilent 1200 Series vacuum degasser is an exception. It can be connected via APG remote connector to the other modules in the stack. An Agilent 1200 Series Instant Pilot can be connected to the CAN bus at any of the modules in the system except for the degasser. Connection to an Agilent data systems is established through an optional LAN board or the built-in LAN port (DAD SL). Although the LAN board can be installed into all modules except for the degasser and the Thermostatted Column Compartment, the LAN port of the detector should be used as the detector generates the highest data rate of all modules. In case the system comprises a G1315C DAD SL, it is mandatory to connect the data system to the LAN port of the DAD SL.For more information about connecting the Instant Pilot or Agilent Data System refer to the respective user manual. For connecting the Agilent 1200 Series equipment to non-Agilent equipment, see Chapter 15, “Hardware Information” in the Binary Pump SL Service Manual.

6 Connect the capillary, solvent tubes and waste tubings (see “Flow Connections with Solvent Selection Valve” on page 41 or “Flow Connections

without Solvent Selection Valve" on page 44).

7 Press the power switch to turn the pump on.

NOTE The power switch stays pressed in and the green indicator LED in the power switch is on while the Binary Pump SL is turned on. When the line power switch stands out and the green light is off, the pump is turned off.

8 Purge the Binary Pump SL (see "Priming the System" on page 47).

WARNING **To disconnect the Binary Pump SL from line power, unplug the power cord. The power supply still uses some power, even if the power switch on the front panel is turned off.**

The pump is shipped with default configuration settings. To change these settings, see "Setting the 8-bit Configuration Switch" in the Binary Pump SL Service Manual.

Flow Connections with Solvent Selection Valve

WARNING **When opening capillary or tube fittings, solvents may leak out. Please observe appropriate safety procedures (for example, goggles, safety gloves and protective clothing) as described in the material handling and safety data sheet supplied by the solvent vendor, especially when toxic or hazardous solvents are used.**

Preparation	Pump is installed in the LC system
Parts required	Other modules Parts from accessory kit (see "Cover Parts" on page 147) Two wrenches 1/4 - 5/16 inch for capillary connections

1 Remove the front cover by pressing the snap fasteners on both sides.

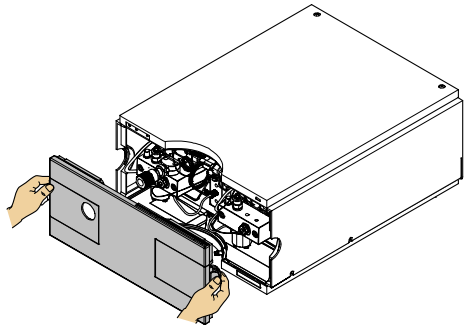

Figure 11 Removing the Front Cover

2 If available, place the online degasser on top of the pump.

3 Place the solvent cabinet on top of the Binary Pump SL.

4 Set the four bottles into the solvent cabinet and screw a bottle head assembly onto each bottle.

5 Connect the solvent tubes from the bottle head assemblies to the inlet connectors A1, A2, B1 and B2 of the solvent selection valve. Make sure to use the brown bottle for the aqueous solvent (usually channel A1).

6 Label the tubes accordingly using the supplied stickers and fix the tubes in the clips of solvent cabinet and Binary Pump SL.

7 Hold the waste tubing with a piece of sandpaper and push it onto the purge valve outlet. Place the end into your waste system.

8 If the Binary Pump SL is not part of an Agilent 1200 Series system stack or placed at the bottom of a stack, connect the corrugated waste tube from the solvent leak drain of the pump to the leak handling system.

9 Connect the outlet capillary (pump to injection device) to the 1/4 inch Sawgelok outlet port of the purge valve.

10 Purge your system prior to the first use (see “Priming the System” on page 47).

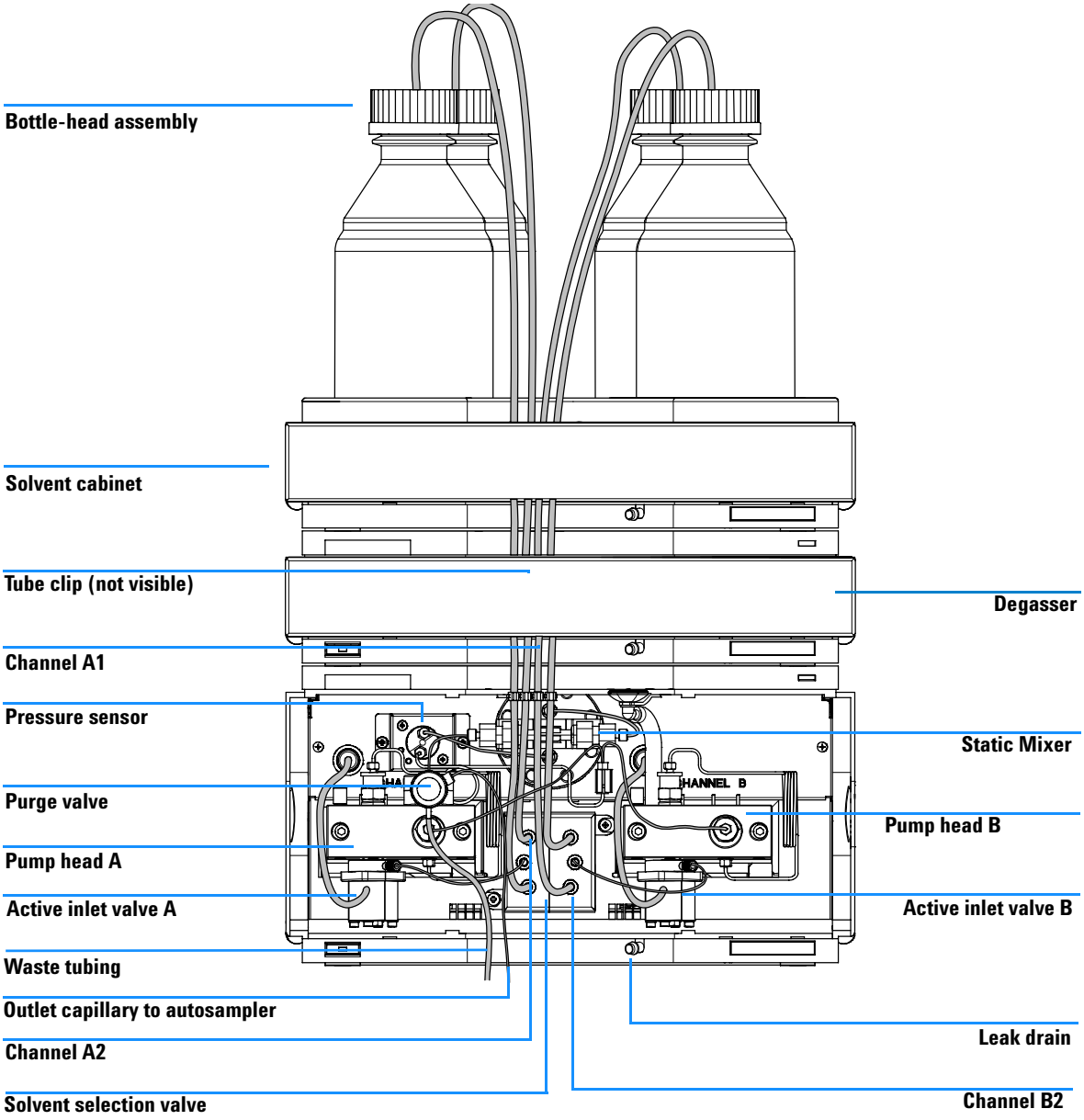

Figure 12 Binary Pump SL with Solvent Selection Valve

Flow Connections without Solvent Selection Valve

WARNING **When opening capillary or tube fittings, solvents may leak out. Please observe appropriate safety procedures (for example, goggles, safety gloves and protective clothing) as described in the material handling and safety data sheet supplied by the solvent vendor, especially when toxic or hazardous solvents are used.**

Preparation	Pump is installed in the LC system
Parts required	Other modules Parts from accessory kit (see "Cover Parts" on page 147) Two wrenches 1/4 - 5/16 inch for capillary connections

1 Remove the front cover by pressing the snap fasteners on both sides.

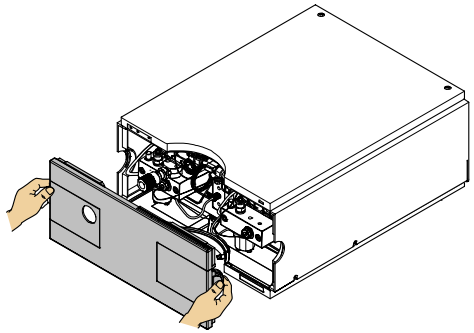

Figure 13 Removing the Front Cover

2 Place the solvent cabinet on top of the Binary Pump SL.

3 Place the bottles into the solvent cabinet and place a bottle head assembly into each bottle.

4 Connect the solvent tubes from the bottle head assemblies to the inlet adapters of the active inlet valves. Fix the tubes in the clips of solvent cabinet and Binary Pump SL.

5 Hold the waste tubing with a piece of sandpaper and push it onto the purge valve outlet. Place the end into your waste system.

6 If the Binary Pump SL is not part of an Agilent1200 System stack or placed at the bottom of a stack, connect the corrugated waste tube from the solvent leak drain of the pump to the leak handling system.

7 Connect the outlet capillary (pump to injection device) to the 1/4 inch Sawgelok outlet port of the purge valve.

8 Purge your system before first use (see “Priming the System” on page 47).

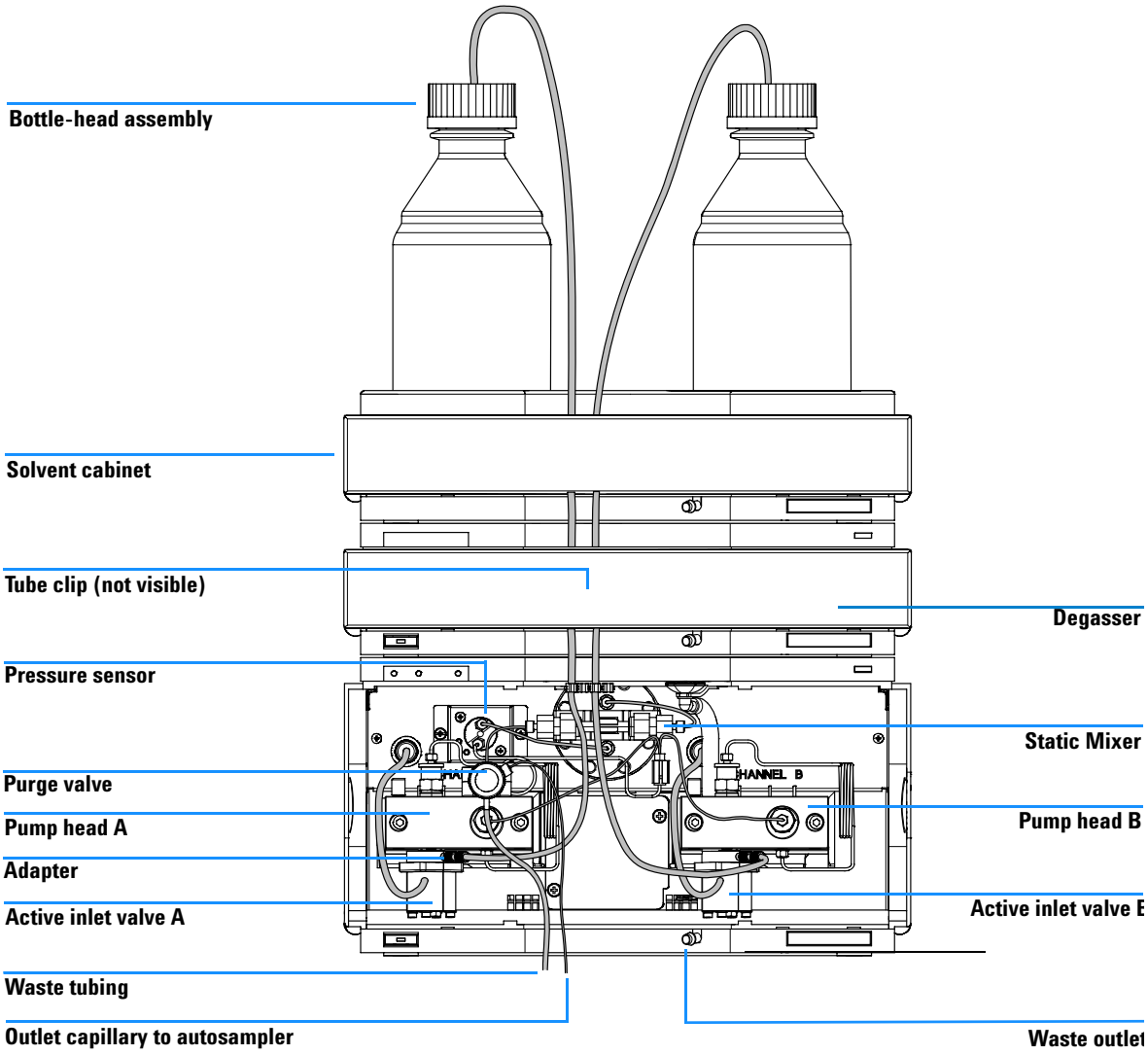

Figure 14 Flow Connection of Binary Pump SL Without Solvent Selection Valve

Priming the System

Initial Priming

Purpose	Before a new degasser or new solvent tubing can be used, it is necessary to prime the system. Isopropanol (IPA) is recommended as priming solvent due to its miscibility with nearly all HLPC solvents and its excellent wetting properties.
Preparation	Connect all modules hydraulically as described in the respective module manuals. Fill each solvent bottle with 100 mL isopropanol Switch the system on
Parts required	Isopropanol

NOTE If the pump is not able to aspirate the solvent from the bottles, a syringe can be used to draw the solvent manually through tubing and degasser.

WARNING **When opening capillary or tube fittings, solvents may leak out. Please observe appropriate safety procedures (for example, goggles, safety gloves and protective clothing) as described in the material handling and safety data sheet supplied by the solvent vendor, especially when toxic or hazardous solvents are used.**

NOTE When priming the vacuum degasser with a syringe, the solvent is drawn through the degasser tubes very quickly. The solvent at the degasser outlet will therefore not be fully degassed. Pump for approximately 10 minutes at your desired flow rate before starting an analysis. This will allow the vacuum degasser to properly degas the solvent in the degasser tubes.

1 Open the purge valve of the pump
2 Set the flow rate to 5 mL/min.
3 Select channel A1
4 Turn the flow on
5 Observe if the solvent in the tubing of channel A1 is advancing towards the pump. If it isn't, disconnect the solvent tubing from the solvent selection valve, attach a syringe with a syringe adapter and pull the liquid through the degasser. Reattach the tubing to the solvent selection valve.
6 Pump 30 mL isopropanol to remove to remove residual air bubbles.
7 Switch to the next solvent channel and repeat steps 5 and 6 until all channels have been purged.
8 Turn the flow off and close the purge valve.

Regular Priming

Purpose	When the pumping system has been turned off for a certain time (for example, overnight) air will rediffuse into the solvent channel between the vacuum degasser and the pump. Solvents containing volatile ingredients will slightly lose these if left in the degasser without flow for a prolonged period of time.
Preparation	Switch the system on
Parts required	none

1 Open the purge valve of your pump by turning it counterclockwise and set the flow rate to 5 mL/min.
2 Flush the vacuum degasser and all tubes with at least 10 mL of solvent.
3 Repeat step 1 and 2 for the other channel(s) of the Binary Pump SL.
4 Set the required composition and flow rate for your application and close the purge valve.
5 Pump for approximately 10 minutes before starting your application.

Changing Solvents

Purpose	When the solvent of a channel is to be replaced by another solvent that is not compatible (solvents are immiscible or one solvent contains a buffer) it is necessary to follow the procedure below to prevent clogging of the pump by salt precipitation or residual liquid droplets in parts of the system.
Preparation	Remove the column and replace it by a ZDV fitting. Prepare bottles with appropriate intermediate solvents (see Table 5 on page 50)
Parts required	Purging solvent(s), see Table 5 on page 50

1 If the channel is not filled with a buffer, proceed to step 4.

2 Place the solvent intake filter into a bottle of water.

3 Flush the channel at a flow rate suitable for the installed tubing (typically 3-5 mL/min) for 10 min.

4 Modify the flow path of your system as required for your application. For delay volume optimization see the Rapid Resolution System manual.

5 Replace the solvent bottle by a bottle of isopropanol.

6 Flush the channel at a flow rate suitable for the installed tubing (typically 3-5 mL/min) for 5 min.

7 Swap the bottle of isopropanol with a bottle of solvent for your application.

CAUTION **Don't perform steps 5 to 7 if the solvent to be run is an aqueous buffer, because buffer salt may precipitate in residual isopropanol and clog the capillaries.**

8 Repeat steps 1 to 7 for the other channel(s) of the Binary Pump SL.

9 Install the desired column, set the required composition and flow rate for your application and equilibrate the system for approx. 10 minutes prior to starting a run.

Table 5 Choice of Priming Solvents for Different Purposes

Activity	Solvent	Comments
After an installation	Isopropanol	Best solvent to flush air out of the system
When switching between reverse phase and normal phase (both times)	Isopropanol	Miscible with almost all solvents
After an installation	Ethanol or methanol	Alternative to isopropanol (second choice) if no isopropanol is available
To clean the system when using buffers	HPLC grade water	Best solvent to re-dissolve buffer crystals
After changing aqueous solvents	HPLC grade water	Best solvent to re-dissolve buffer crystals
After the installation of normal phase seals (P/N 0905-1420)	Hexane + 5% isopropanol	Good wetting properties

4
Using the Pump

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Setting the Pump up with the G4208A Instant Pilot 55
Setting the Pump up with Agilent ChemStation 56
Setup of Basic Pump Parameters 58
Pump Control 60
Auxiliary Pump Parameters 61
Data Curves 63
Bottle Filling 64
Early Maintenance Feedback (EMF) 66

This chapter explains the operational parameters of the Binary Pump SL.

Hints for Successful Use of the Binary Pump SL

- Place solvent cabinet with the solvent bottles always on top (or at a higher level) of the Binary Pump SL.
- When using the Binary Pump SL without vacuum degasser, shortly degas your solvents (for example, water vacuum pump for 15 – 30 s in an appropriate vessel) before using them in the pump. If possible apply solvent conditions that will decrease the gas solubility over time (for example, warming up the solvents).
- The use of a vacuum degasser is mandatory for flow rates below 0.5 mL/min and for configurations without damper and mixer.
- When using the binary pump with vacuum degasser, flush the degasser with at least 5 mL per channel before operating the Binary Pump SL, especially when the pumping system had been turned off for a certain length of time (for example, overnight) and volatile solvent mixtures are used in the channels (see "Regular Priming" on page 48).
- Prevent blocking of solvent inlet filters (never use the pump without solvent inlet filters). Growth of algae should be avoided (see "Prevent Blocking of Solvent Filters" on page 70).
- Check purge valve frit and column frit in regular time intervals. A blocked purge valve frit can be identified by black, yellow or greenish layers on its surface or by a pressure greater than 10 bar when pumping distilled water at a rate of 5 ml/min with an open purge valve.
- Whenever possible use a minimum flow rate of 5 µl/min per solvent channel to avoid crossflow of solvent into the unused pump channel.
- Whenever exchanging the pump seals, the purge valve frit should be exchanged, too.
- When using buffer solutions, flush the system with water before switching it off. The seal wash option should be used when buffer solutions with concentrations of 0.1 M or higher are being pumped for long periods of time.
- Check the pump plungers for scratches, grooves and dents when changing the piston seals. Damaged plungers cause micro leaks and will decrease the lifetime of the seals.

- After changing the plunger seals, apply the seal wear-in procedure (see page 107).
- Place the aqueous solvent on channel A and the organic solvent on channel B. The default compressibility settings are set accordingly.

Solvent Information

Always filter solvents through 0.4 µm filters. Small particles can permanently block the capillaries and valves. Avoid the use of the following steel-corrosive solvents:

- Solutions of alkali halides and their respective acids (for example, lithium iodide, potassium chloride, and so on).
- High concentrations of inorganic acids like sulfuric and nitric acid, especially at higher temperatures (replace, if your chromatography method allows, by phosphoric acid or phosphate buffer which are less corrosive to stainless steel).
- Halogenated solvents or mixtures which form radicals and/or acids, for example:

  $$2CHCl_3 + O_2 \rightarrow 2COCl_2 + 2HCl$$

  This reaction, in which stainless steel probably acts as a catalyst, occurs quickly with dried chloroform if the drying process removed the stabilizing alcohol.
- Chromatographic grade ethers, which can contain peroxides (for example, THF, dioxane, di-isopropylether). Such ethers should be filtered through dry aluminium oxide which adsorbs the peroxides.
- Solvents containing strong complexing agents (e.g. EDTA).
- Mixtures of carbon tetrachloride with 2-propanol or THF dissolve stainless steel.

Setting the Pump up with the G4208A Instant Pilot

Generic operation of the G4208A Instant Pilot is covered in the Instant Pilot User's Guide, part number G4208-90000. Details about setting up module specific parameters can be found in the Instant Pilot online help.

The pump parameters are described in depth in "Setting the Pump up with Agilent ChemStation" on page 56

Setting the Pump up with Agilent ChemStation

Overview

The pump parameters are grouped into six different panels:

- Set up Pump
- More Pump
  - Auxiliary
  - Data Curves
  - Bottle Filling
  - Contacts
  - Control

Most of these panels can be accessed in two different ways:
Pulling down the *Instrument* menu or left-clicking on the pump icon the GUI.

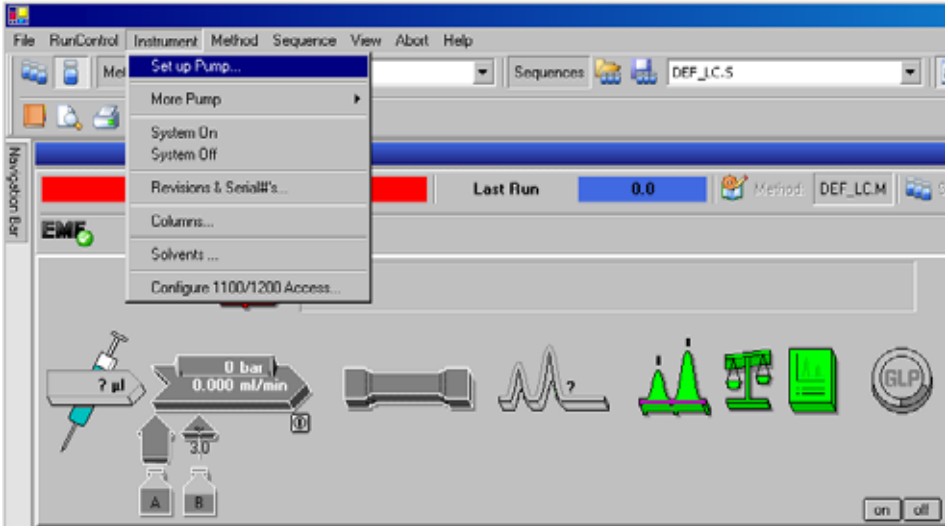

Figure 15 Pump Parameters in the *Instrument* Menu

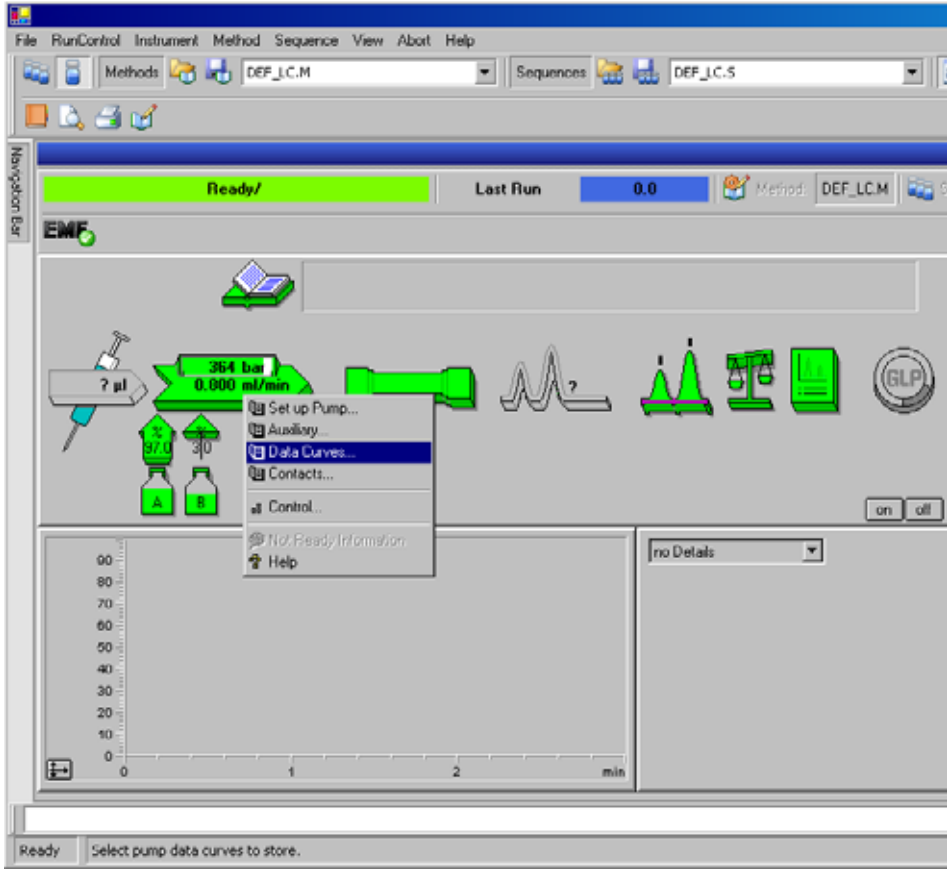

Figure 16 Popup Menu of the Pump Icon

Setup of Basic Pump Parameters

The most important parameters of the pump are grouped in the *Set up Pump* panel. Open it either from the *Instrument* menu or by left-clicking the pump icon in the graphical user interface (GUI).

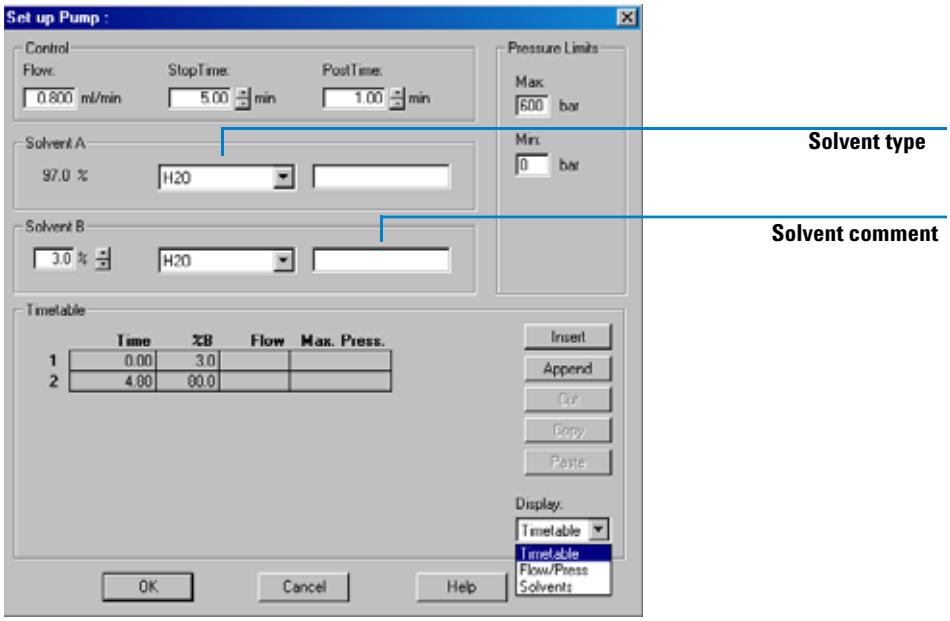

Figure 17 *Set up Pump* Panel

Table 6 Parameters of the *Set up Pump* Panel

Parameter	Limits	Description
• Flow	0.001 - 5 mL/min	Total flow rate of the pump. See "When to Remove Damper and Mixer" on page 75 for pump hardware modifications to achieve lowest delay volume.
• Stop Time	0.01 min - no limit	The stop time of the pump usually controls the run time of the whole LC system. Use *no limit* to stop the run manually (useful for method development).
• Post Time	off - 99999 min	Time between the end of a run and the start of the next. Used for column equilibration after a gradient.

Table 6 Parameters of the *Set up Pump* Panel

Parameter	Limits	Description
• Pressure Limits	Max: 0 - 600 bar Min: 0 - 600 bar	Max must be bigger than Min! Set max pressure to the maximum operating pressure of your column. A min pressure setting of e.g. 10 bar will turn off your pump automatically when running out of solvent. A smarter way, however, is to use the bottle fillings function (see page 64).
• Solvent A	0 - 100%	Although channel A can be set to 0%, it cannot be turned off. This channel should be used for the aqueous phase (water).
• Solvent B	off - 100%	The percentage of channel B is automatically complemented by channel A to give 100%.
• (Solvent type)	H_2O, ACN, MeOH, IPA	Select the solvent you are using in the respective solvent channel from the drop-down list. In case your solvent is not listed, perform a solvent compressibility calibration.
• (Solvent Comment)		Free text field for a description of the solvent. This description will show up in method printouts, etc.
• Timetable	max. number of lines depends on free space in pump memory.	Use the timetable to build solvent gradients, flow gradients, or combinations of both. Gradients are always linear. Use multiple timetable entries to mimic exponential or parabolic gradients.
• Display		There are three ways to display the timetable: • in tabular form • as flow/pressure graph • as solvent percentage plot **Values can only be changed in tabular view.**

Pump Control

This panel is used to turn the pump on and off, operate the optional seal wash pump and define an error method.

It can be accessed via menu *Instrument - More Pump - Control* or by left-clicking the pump icon in the GUI.

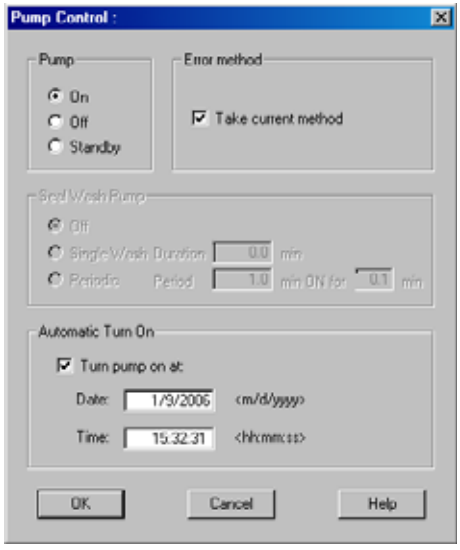

Figure 18 *Pump Control* Panel

Pump

The pump group enables you to switch the pump **On**, **Off** or to **Standby**. In Standby, the pump motor is still energized. When the pump is switched on again, it does not re-initialize.

CAUTION

Upon initialization, the pump ignores the **Maximum Flow Gradient** value (see page 62). This can result in a rapid and uncontrolled pressure increase. To prevent harm to the column, open the purge valve until the initialization is finished.

Auxiliary Pump Parameters

The parameters in this panel are pre-set to fit most applications. Adjustments should only be made when required.
The Pump Auxiliary panel can be accessed by either pulling down the *Instrument* menu and selecting *More Pump - Auxiliary* or by left-clicking the pump icon in the GUI.

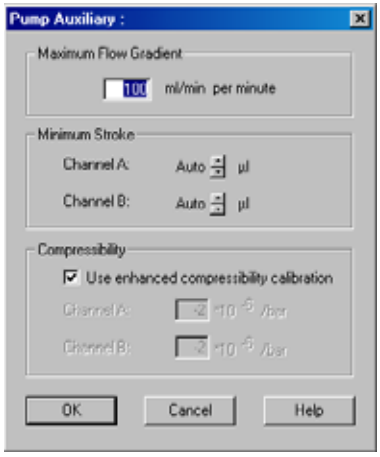

Figure 19 *Pump Auxiliary* Parameter Panel

Table 7 Parameters of the *Pump Auxiliary* Panel

Parameter	Limits	Description
• Maximum Flow Gradient	0.1 - 100 mL/min^2 default: 100 mL/min^2	With this parameter flow rate changes can be ramped up and down slowly to avoid pressure shocks to the column. The default value is 100 ml/min^2 which in fact turns the function off. **Caution!** The flow is shut off immediately when the pump switched to standby. When the pump is turned **On** from the **Off status**, the pump drive initializes, thereby ignoring the maximum flow gradient setting. Depending on system delay volume and flow restriction, the system pressure may rise very quickly to a high value. To protect your column from damage, it is suggested to open the purge valve during initialization.
• Minimum Stroke	20 µL - 100 µL default: Auto	The volume one pump piston delivers per stroke. Generally, a smaller stroke volume results in lower pump ripple. The **Auto** setting adjusts the strokes dynamically to the lowest possible value. The strokes can be set individually for pump heads A and B.
• Compressibility	0 - 150 E10^{-6}/bar or enhanced compressibility calibration default: use enhanced comp. calibration	It is highly recommended to tick the *Use enhanced compressibility calibration* box. This forces the pump to use either stored solvent compressibility data or user generated compressibility parameters from solvent compressibility calibrations. For legacy support, the solvent compressibility can still be set manually for each channel when the box is unticked.

Data Curves

The Binary Pump SL provides the possibility to store operational data in the data file of the Agilent data system.

Solvent percentage for each channel, pump flow and pressure are stored when the respective boxes are ticked.

Access the *Data Curves* panel either from the *Instrument - More Pump - Data Curves* menu or by left-clicking the pump icon in the GUI.

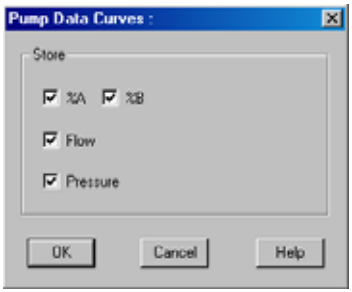

Figure 20 *Data Curves* Panel

NOTE The pressure data curve is **generated** from the pressure sensor readings, while %A, %B and flow are **calculated** from the method settings of the pump.

Bottle Filling

The pump offers a powerful feature to monitor the liquid level in the solvent bottles. With total bottle volume and initial filling volume set correctly, the pump subtracts the displaced volume continuously from the initial value and reacts before the system runs dry or an analysis is corrupted.

The Bottle Filling panel can be found in *Instrument - More Pump - Bottle Filling* or by left-clicking on the solvent bottles below the pump icon in the GUI.

Figure 21 *Bottle Filling* Panel

Table 8 *Bottle Filling* Parameters

Parameter	Limits	Description
• Total Volume	0 - 1000 L default: 0 L	Enter the total capacity of the solvent vessel in this box. Mind that the dimension is Liters!
• Actual Volume	0 - 1000 L default: 0 L	After filling the solvent bottles, enter the actual volumes into these boxes. The actual volume must not be larger than the total volume of the bottle.

Parameter	Limits	Description
• Prevent analysis.....	default: turned off	When ticked, the pump won't start a new run if the solvent level in one or more bottles is below the given value. When setting this parameter, consider the size and shape of the solvent vessel and make sure the pump does not draw air when coming close to the limit.
• Turn pump off...	default: turned off	When ticked, the pump will turn off before air is aspirated. However, the residual solvent volume has been calculated for 1 L solvent bottles and may be too small for large bottles or other vessels.

CAUTION

The bottle filling feature will fail if multiple channels are fed from one solvent bottle!

In that case implement a minimum pressure limit (see page 59) to avoid that the Binary Pump SL runs dry when solvents are empty,

Early Maintenance Feedback (EMF)

Maintenance requires the exchange of components in the flow path which are subject to mechanical wear or stress. Ideally, the frequency at which components are exchanged should be based on the intensity of usage of the instrument and the analytical conditions, and not on a predefined time interval. The early maintenance feedback (EMF) feature monitors the usage of specific components in the instrument, and provides feedback when the user-settable limits have been exceeded. The visual feedback in the user interface provides an indication that maintenance procedures should be scheduled.

EMF Counters

The binary pump provides a series of EMF counters for the left and right pump heads. Each counter increments with pump use, and can be assigned a maximum limit which provides visual feedback in the user interface when the limit is exceeded. Each counter can be reset to zero after maintenance has been done. The binary pump provides the following EMF counters:

- liquimeter pump A,
- seal wear pump A,
- liquimeter pump B, and
- seal wear pump B.

Liquimeters

The liquimeters display the total volume of solvent pumped by the left and right pump heads since the last reset of the counters. Both liquimeters can be assigned an EMF (maximum) limit. When the limit is exceeded, the EMF flag in the user interface is displayed.

Seal Wear Counters

The seal wear counters display a value derived from pressure and flow (both contribute to seal wear). The values increment with pump usage until the counters are reset after seal maintenance. Both seal wear counters can be assigned an EMF (maximum) limit. When the limit is exceeded, the EMF flag in the user interface is displayed.

Using the EMF Counters

The user-settable EMF limits for the EMF counters enable the early maintenance feedback to be adapted to specific user requirements. The wear of pump components is dependent on the analytical conditions, therefore, the definition of the maximum limits need to be determined based on the specific operating conditions of the instrument.

Setting the MF Limits

The setting of the EMF limits must be optimized over one or two maintenance cycles. Note the pumped volumes and the seal wear values of both pump heads when symptoms of excessive seal wear are observed. Perform pump maintenance and enter the noted EMF values minus a safety margin of 10% as new EMF limits. Reset the EMF counters to zero. The next time the EMF counters exceed the new EMF limits, the EMF flag will be displayed at the appropriate time, providing a reminder that maintenance needs to be scheduled

5 Optimizing Performance

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When to Use a Vacuum Degasser 72
When to Use the Active Seal Wash Option 73
When to Use Alternative Seals 74
When to Remove Damper and Mixer 75
How to Optimize the Compressibility Compensation Setting 78

This chapter gives information on how to optimize the performance of the Binary Pump SL under special operational conditions.

Prevent Blocking of Solvent Filters

Contaminated solvents or algae growth in the solvent bottle will reduce the lifetime of the solvent filter and will influence the performance of the Binary Pump SL. This is especially true for aqueous solvents or phosphate buffers (pH 4 to 7). The following suggestions will prolong lifetime of the solvent filters and maintain the performance of the Binary Pump SL.

- Use a sterile, if possible amber, solvent bottle to slow down algae growth.
- Filter solvents through filters or membranes that remove algae.
- Exchange aqueous solvents every two days or refilter.
- If the application permits, add 0.0001 to 0.001 Molar sodium azide to the solvent.
- Place a layer of argon on top of your solvent.
- Avoid exposure of the solvent bottles to direct sunlight.

Checking the Solvent Filters

The solvent filters are located on the low-pressure side of the Binary Pump SL. A blocked filter therefore does not necessarily affect the high pressure readings of the pump. The pressure readings cannot be used to check whether the filters are blocked or not. If the solvent cabinet is placed on top of the Binary Pump SL, the filter condition can be checked in the following way:

Remove the solvent inlet tube from the inlet port of the solvent selection valve or the adapter at the active inlet valve. If the filter is in good condition, the solvent will freely drip out of the solvent tube (due to hydrostatic pressure). If the solvent filter is partly blocked only very little solvent will drip out of the solvent tube.

WARNING **When opening capillary or tube fittings, solvents may leak out.Please observe appropriate safety procedures (for example, goggles, safety gloves and protective clothing) as described in the material handling and safety data sheet supplied by the solvent vendor, especially when toxic or hazardous solvents are used.**

Cleaning the Solvent Filters

- Remove the blocked solvent filter from the bottle-head assembly and place it in a beaker with concentrated nitric acid (35%) for one hour.
- Thoroughly flush the filter with HPLC-grade water (remove all nitric acid, some capillary columns can be damaged by nitric acid).
- Replace the filter.

NOTE Never use the system without solvent filter installed.

When to Use a Vacuum Degasser

The Binary Pump SL does not necessarily require degassing. However, for the following conditions a vacuum degasser is mandatory:

- Your detector is used with maximum sensitivity in the low UV wavelength range,
- Your application requires highest injection precision, or
- Your application requires highest retention-time reproducibility (flow rates below 0.5 mL/min).
- The Binary Pump SL is used with bypassed damper and mixer.

Operational Hints for the Vacuum Degasser

If you are using the vacuum degasser for the first time, if the vacuum degasser was switched off for any length of time (for example, overnight), or if the vacuum degasser chambers are empty, you have to prime the vacuum degasser before running an analysis. Priming is usually done by pumping at a high flow rate (3 - 5 mL/min). Alternatively, a syringe can be used to draw the solvent through the (empty) degasser if the pump does not aspirate the solvent by itself.
For details see “Priming the System” on page 47.

For more information see the *Reference Manual* of the Agilent 1200 Series vacuum degasser.

When to Use the Active Seal Wash Option

Concentrated buffer solutions will reduce the lifetime of the seals and plungers in your Binary Pump SL. The active seal wash option allows to maintain the seal lifetime by flushing the low pressure side of the seals with a wash solvent.

The seal wash option is strongly recommended if buffer concentrations of 0.1 M or higher are used regularly with the Binary Pump SL.

The active seal wash option kit can be ordered by quoting part number G1312-68712.

The seal wash option comprises a peristaltic pump, secondary seals, gaskets, seal keepers and tubing for both pump heads. A bottle of premixed water/isopropanol (90/10 vol%) is placed in the solvent cabinet and connected to the peristaltic pump as described in the technical note that comes with the active seal wash kit.

Always use a mixture of HPLC-water (90 %) and isopropanol (10 %) as wash solvent. This mixture prevents bacteria growth in the wash bottle and reduces the surface tension of the water.

The operation of the peristaltic pump can be controlled from the data system or the Instant Pilot.

NOTE

The Binary Pump SL comes with pre-installed seal wash capable support rings.
When the user decides to use seal wash it is recommended to replace the secondary seals and gaskets by new ones to ensure tightness.

For information on the installation of the continuous seal wash option refer to "Installing the Active Seal Wash Option" on page 126.

When to Use Alternative Seals

The standard seals for the Binary Pump SL can be used for most applications. However, normal phase applications (for example, hexane) are not compatible with the standard seals. They cause extremely high abrasion and significantly shorten seal life time.

Special polyethylene pistons seals (yellow color), part number 0905-1420 (pack of 2). These seals have less abrasion compared to the standard seals.

NOTE Polyethylene seals have a limited pressure range of 0–200 bar.
When used above 200 bar, their lifetime will be significantly reduced.

WARNING **DO NOT apply the seal wear-in procedure performed to normal phase seals (yellow) because they will be destroyed by the procedure.**

When to Remove Damper and Mixer

The Binary Pump SL is equipped with a pressure pulsation damper and a static mixer. The total delay volume of the pump is 600 – 800 µL (depending on system pressure). The mixer has a volume of 400 µL.

For applications that require lowest delay volume (e.g. fast gradient methods or gradient applications with low flow rates), damper and mixer can be bypassed. (see Figure 22)

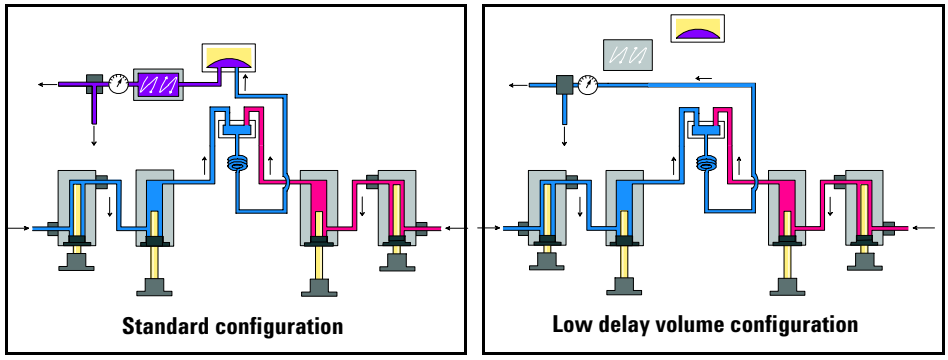


Figure 22 Flow Path Modifications of the Binary Pump SL

Both configurations have advantages and weaknesses. For use with Agilent 1200 Series Rapid Resolution System check the System Configuration Optimizer on the CD-ROM that shipped with the pump for detailed plumbing recommendations for your application.

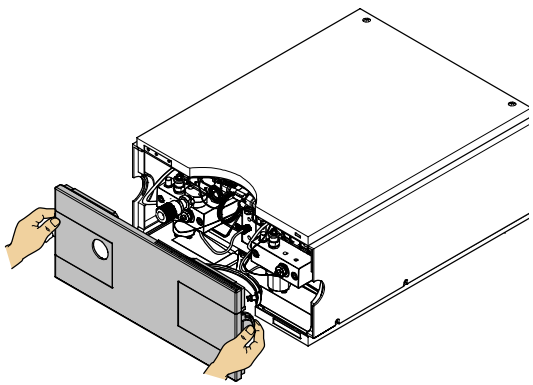
Convert the Binary Pump SL to Low Delay Volume Mode

The Binary Pump SL is delivered in standard configuration (damper and mixer connected). This paragraph shows how to bypass damper and mixer and convert the pump to low delay volume mode.

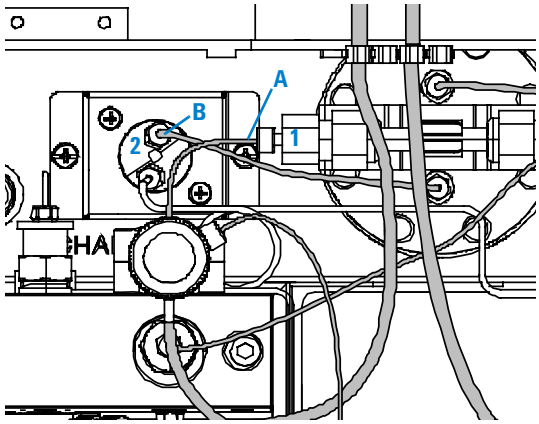
Configurations where only damper or mixer are disconnected while the other part is still in line are not supported by Agilent Technologies.

Tools required	Wrench 1/4 – 5/16 inch, part no. 8710-0510 Wrench, 14 mm, part no. 8710-1924 Hex driver open, 1/4 inch, part no. 5023-0240
Preparations for this procedure	Flush the system (water if buffers were used, otherwise IPA). Turn the flow off.

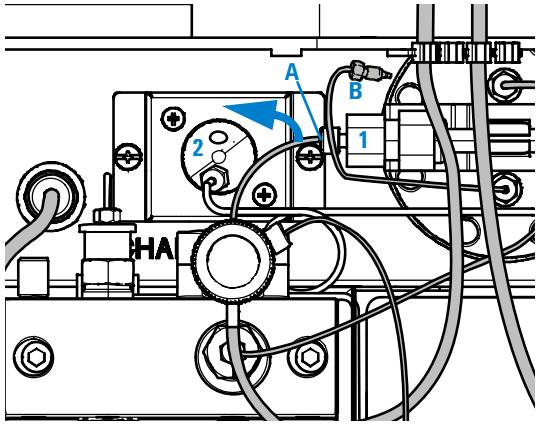
1 Remove the front cover by pressing the clip fastener on both sides of the cover.



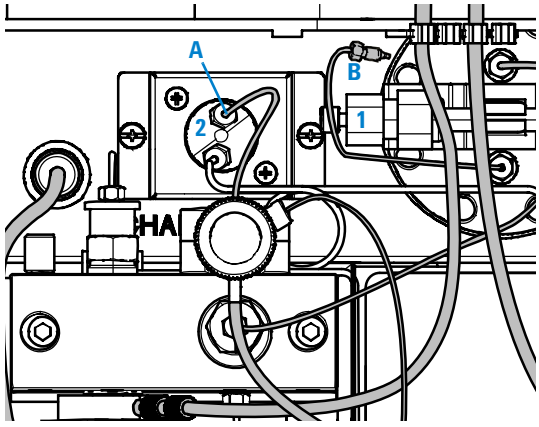
2 Use the 1/4 inch hex driver to remove fitting **B** from port **2** of the pressure sensor.



3 Fold capillary end **B** away. It remains unconnected. Disconnect fitting **A** from outlet **1** of the mixer.



4 Connect fitting **A** to port **2** of the pressure sensor. Seal port **1** of the mixer with a plastic blank nut.



How to Optimize the Compressibility Compensation Setting

When a solvent is metered at ambient pressure and compressed to a higher pressure, the volume decreases. This is due to an effect known as solvent compressibility. Solvent compressibility is a non-linear function of pressure and temperature. It is unique to every solvent.

In order to deliver the desired flow accurately at all pressures, Agilent pumps use a compressibility compensation. Usually, an average compressibility value for the solvent is used across the whole pressure range of the pump.

The G1312B Binary Pump SL introduces a new compressibility compensation concept. The compressibility of a solvent is determined at different pressures between 0 to 600 bar. The pump uses the obtained non-linear function to select the correct compressibility value for the actual pump pressure. Compressibility data for the most common solvents is readily available in the pump firmware.

The compensation algorithm is so powerful that the damper and mixer can be removed from the pump flow path at low flow rate while the pressure ripple and composition ripple remain at low levels.

For method compatibility reasons, the legacy compressibility compensation is still available.

Solvent Compressibility Calibration

Unlisted or premixed solvents can be calibrated with the Solvent Compressibility Calibration function. For a detailed description, see page 89.

Optimization of Legacy Compressibility Settings

The compressibility compensation default settings are 50×10^{-6} /bar (best for most aqueous solutions) for pump head A and 115×10^{-6} /bar (to suit organic solvents) for pump head B. The settings represent average values for aqueous solvents (A side) and organic solvents (B side). Therefore it is always recommended to use the aqueous solvent on the A side of the pump and the organic solvent on the B side. Under normal conditions, the default settings reduce the pressure pulsation to below 2 % of system pressure, which is sufficient for most applications. If the compressibility values for the solvents used differ from the default settings, it is recommended to change the compressibility values accordingly. Compressibility settings can be optimized by using the values for various solvents described in Table 9 on page 80. If the solvent in use is not listed in the compressibility table, when using premixed solvents and if the default settings are not sufficient for your application, the following procedure can be used to optimize the compressibility settings:

1 Start channel A of the Binary Pump SL with the required flow rate.

2 Before starting the optimization procedure, the flow must be stable. Use degassed solvent only. Check the tightness of the system with the pressure test (see "Pressure Test" on page 82).

3 Your pump must be connected to a Chemstation or Instant Pilot, the pressure- and %-ripple can be monitored with one of these instruments, otherwise connect a signal cable between the pressure output of the isocratic pump and a recording device (for example, 339X integrator) and set following parameters.

   Zero 50 %
   Att 2^3
   Chart Speed 10 cm/min

4 Start the recording device in plot mode.

5 Starting with a compressibility setting of 10×10^{-6} /bar, increase the value in steps of 10. Re-zero the integrator as required. The compressibility compensation setting that generates the smallest pressure ripple is the optimum value for your solvent composition.

6 Repeat step 1 through step 5 for the B channel of your Binary Pump SL.

Table 9 Solvent Compressibility

Solvent (pure)	Compressibility (10^{-6}/bar)
Acetone	126
Acetonitrile	115
Benzene	95
Carbon tetrachloride	110
Chloroform	100
Cyclohexane	118
Ethanol	114
Ethyl acetate	104
Heptane	120
Hexane	150
Isobutanol	100
Isopropanol	100
Methanol	120
1-Propanol	100
Toluene	87
Water	46

6
Tests and Calibration Functions

Pressure Test 82
Pump Test 87
Solvent Compressibility Calibration 89
Pump Elasticity Calibration 91

This chapter explains all test functions that are available for the Binary Pump SL.

Pressure Test

Description

The pressure test is a quick built-in test designed to demonstrate the leak tightness of the system. The test involves monitoring the flow profile while the Binary Pump SL delivers against a blank nut. The result is presented as the leak rate of the pump and provides information about the leak tightness of the system between the outlet ball valves of the Binary Pump SL and the blank nut.

NOTE The blank nut can be positioned anywhere between the purge valve of the pump and the detector inlet to pressure test the desired part of the system.

CAUTION Never include the flow cell in the pressure test as the applied pressure may cause permanent leaks or bursting (FLD, RID) of the flow cell.

Step 1

The test begins with the initialization of both pump heads. After initialization, the pump is starting the compression phase and the required flow rate is constantly monitored and adjusted. The Binary Pump SL continues to pump until a system pressure of around 600 bar is reached.

Step 2

When the system pressure reaches 600 bar, the Binary Pump SL continues to pump at a flow rate that keeps the pressure constant. The flow that is needed to keep the pressure constant is directly translated into a leak rate.

Positioning the blank nut

To test the complete system for pressure tightness, the blank nut should be positioned at the column compartment outlet (or the outlet of the last module in front of the detector).

If a specific component is suspected to cause the system leak, place the blank nut immediately in front of the suspected component, and run the pressure test again. If the test passes, the defective component is located behind the blank nut. Confirm the diagnosis by placing the blank nut immediately behind the suspected component. The diagnosis is confirmed if the test fails.

Running the Pressure Test

When required	The test should be used when problems with small leaks are suspected, or after maintenance of flow path components (e.g., pump seals, injection seal) to prove pressure tightness up to 600 bar
Tools required	• Wrench 1/4 - 5/16 inch, e.g. PN 8710-0510 • 1/16 inch blank nut, PN 01080-83202
Preparations for this procedure	Place two bottles of HPLC-grade water in channels A and B (A1 and B1 if the pump is equipped with a solvent selection valve)

NOTE Make absolutely sure that all parts of the flow path that are part of the test are very thoroughly flushed with water before starting to pressurize the system! Any trace of other solvents or the smallest air bubble inside the flow path definitely will cause the test to fail!

Running the test from the Agilent LC Diagnostic Software

1 Select the pressure test from the test selection menu.

2 Start the test and follow the instructions.

NOTE Make sure to release the pressure by opening the purge valve when the test has finished completed.
Otherwise the pump may generate an overpressure error.

Evaluating the Results

The sum of all leaks between the pump and the blank nut will add up to the total leak rate. Note that small leaks may cause the test to fail, but solvent may not be seen leaking from a module.

NOTE Please notice the difference between an ***error*** in the test and a ***failure*** of the test! An ***error*** is caused by the abnormal termination during the operation of the test whereas a ***failure*** of a test indicates that the test results were not within the specified limits.

If the pressure test fails:

- Ensure all fittings between the pump and the blank nut are tight. Repeat the pressure test.

NOTE Often it is only a damaged blank nut itself (poorly shaped from overtightening) that causes the test to fail. Before investigating on any other possible sources of failure make sure that the blank nut you are using is in good condition and properly tightened!

- If the test fails again, insert the blank nut at the outlet of the previous module in the stack (e.g. autosampler, port 6 of the injection valve), and repeat the pressure test. Exclude each module one by one to determine which module is leaking.
- If the pump is determined to be the source of the leak, run the pump test to identify the defective pump component.

Potential Causes of Pressure Test Failure

After isolating and fixing the cause of the leak, repeat the pressure test to confirm the system is pressure tight.

Table 1

Potential Cause (Pump)	Corrective Action
Purge valve open.	Close the purge valve.

Table 1

Loose or leaky fitting.	Tighten the fitting or exchange the capillary.
Damaged pump seals or plungers.	Run the pump test to identify the defective component.
Loose purge valve.	Tighten the purge valve nut (14 mm wrench).

Table 2

Potential Cause (Autosampler)	Corrective Action
Loose or leaky fitting.	Tighten or exchange the fitting or capillary.
Rotor seal (injection valve).	Exchange the rotor seal.
Damaged metering seal or plunger.	Exchange the metering seal. Check the plunger for scratches. Exchange the plunger if required.
Needle seat.	Exchange the needle seat.

Table 3

Potential Cause (Column Compartment)	Corrective Action
Loose or leaky fitting.	Tighten or exchange the fitting or capillary.
Rotor seal (column switching valve).	Exchange the rotor seal.

Pump Test

Description

The pump test provides a fast and accurate way to verify proper hydraulic operation of the Binary Pump SL. Problems related to defective valves, seals or pistons can be diagnosed and usually the defective part is identified.

Step 1

The system is setup with water on both channels and a restriction capillary is attached to the outlet of the pump.
Pump head A is delivering at 1 mL/min. The pressure signal is monitored and overlaid with the piston movement plot. The pressure pattern and the slope of the pressure signal are evaluated for the delivery strokes of both pistons.

Step 2

The procedure from step 1 is repeated on pump head B.

Step 3

The data from step 1 and 2 are evaluated. In case test failed, a conclusion about the defective part is made.

Running the Pump Test

When required	The test should be used to prove proper operation of the Binary Pump SL after repairs or when a the pressure test (see page 82) determined a problem with the pump.
Tools required	• Wrench 1/4 - 5/16 inch, e.g. PN 8710-0510 • Restriction capillary, PN G1312-67500
Preparations for this procedure	Place two bottles of HPLC-grade water in channels A and B (A1 and B1 if the pump is equipped with a solvent selection valve)

NOTE Make absolutely sure that the pump is very thoroughly flushed with water before starting the test! Any trace of other solvents or the smallest air bubble inside the flow path definitely will cause the test to generate misleading results!

Running the test from the Agilent LC Diagnostic Software

1 Select the pump test from the test selection menu.

2 Start the test and follow the instructions.

NOTE Make sure to release the pressure by opening the purge valve when the test is completed. Otherwise the pump may generate an overpressure error.

Evaluating the Results

Refer to the help file of the Agilent LC Diagnostic Software for further details.

Solvent Compressibility Calibration

Description

Each solvent or solvent mixture has unique compressibility at different pressures. In order to deliver accurate flow with minimal pressure- and composition ripple over the full operational pressure range, it is necessary that the Binary Pump SL compensates precisely for the compressibility of the solvents in use.

The Binary Pump SL comes with compressibility parameters for the most common HPLC solvents and solvent mixtures. If a solvent is not available in the list of pre-calibrated solvents, the solvent compressibility calibration allows to generate appropriate compressibility data.

Technical background

The solvent compressibility calibration relies on an accurate elasticity calibration of the pump. With a proper elasticity calibration in place, the pump is switched into pressure control mode. A restriction capillary is connected to the purge valve outlet. By varying the flow rate, the pump maintains a certain pressure. The pump optimizes the compressibility value of the solvent until the lowest possible pump ripple is reached. The pump increases the flow rate and adjusts the pressure to the next calibration step where the pump ripple is minimized again. This process is repeated until solvent compressibility data for the whole operating pressure range of the pump are available.

The compressibility data set for this solvent is stored in an XML-file and can be shared with other G1312B pump via Agilent ChemStation.

Running the Solvent Compressibility Calibration

When required	If a solvent is not available in the list of pre-calibrated solvents, the solvent compressibility calibration allows to generate appropriate compressibility data.
Tools required	• Wrench 1/4 - 5/16 inch, e.g. PN 8710-0510 • Restriction capillary, PN G1312-67500
Preparations for this procedure	Place a bottles with solvent to be calibrated in channel A (resp. A1 if a solvent selection valve is installed).

CAUTION Accurate pump elasticity calibration is required to obtain valid and portable solvent compressibility data.

NOTE Make absolutely sure that the pump is very thoroughly flushed with the solvent to be calibrated before starting the procedure! Any trace of other solvents or the smallest air bubble inside the flow path definitely will cause the calibration to fail!

Running the Solvent Compressibility Calibration from the Agilent LC Diagnostic Software

1 Select the solvent from the test selection menu.

2 Start the test and follow the instructions.

NOTE Make sure to release the pressure by opening the purge valve when the test is completed. Otherwise the pump may generate an overpressure error.

Pump Elasticity Calibration

Description

The flow path components of the Binary Pump SL pump have an inherent and pressure dependent elasticity which differs from pump to pump. When this elasticity/pressure function is known, a correction algorithm can be applied. This results in significantly improved pump performance in low delay volume mode (damper and mixer bypassed).

The pump elasticity calibration uses a solvent with well known properties (HPLC-grade water) to determine the pump elasticity over the entire operating pressure range and stores the calibration values in the non-volatile RAM of the pump mainboard.

The initial calibration is done at the factory. It only needs to be repeated after replacement of major pump parts (mainboard, pump drive). The test allows to define which pump head will be calibrated.

NOTE Results of the pump elasticity calibration rely on known compressibility parameters for pure water. If the water is not HPLC-grade, not well degassed or degasser and pump are not flushed properly, the pump elasticity calibration will fail. The pump elasticity calibration has to be performed for each pump head individually.

CAUTION Missing or inaccurate pump elasticity calibration will result in a wrong solvent compressibility calibration (see page 89) parameters

Running the Pump Elasticity Calibration

When required	The initial calibration is done at the factory. It only needs to be repeated after replacement of major pump parts (mainboard, pump drive).
Tools required	Wrench 1/4 - 5/16 inch, e.g. PN 8710-0510 Restriction capillary, PN G1312-67500
Preparations for this procedure	Place all bottle heads in to a bottle of HPLC-grade water.

NOTE Make absolutely sure that the pump is very thoroughly flushed with the solvent to be calibrated before starting the procedure! Any trace of other solvents or the smallest air bubble inside the flow path definitely will cause the calibration to fail!

NOTE If a solvent selection valve is installed flush all four solvent channels to avoid that air from a dry solvent intake tube is drawn into the flow path upon initialization.

Running the Pump Elasticity Calibration from the Agilent LC Diagnostic Software

1 Select the pump elasticity calibration from the test selection menu.

2 Start the test and follow the instructions.

7
Maintenance and Repair

Introduction to Maintenance and Repair 94
Warnings and Cautions 95
Cleaning the Binary Pump SL 96
Using the ESD Strap 97

This chapter provides general information on repairing the Binary Pump SL.

Introduction to Maintenance and Repair

Simple Repairs - Maintenance

The pump is designed for easy repair. The most frequent repairs such as piston seal replacement and purge valve frit exchange can be done from the front side without removing the pump from the system stack. These repairs are described in "Overview of Maintenance and Simple Repairs" on page 100(**part of the *User Manual* and *Service Manual***).

Exchanging Internal Parts - Repair

Some repairs require the exchange of defective internal parts. Exchange of these parts involves removing the pump from the stack, removing the covers, and disassembling the module. The security lever at the power input socket prevents that the detector cover is taken off when line power is still connected. These repairs are described in the Binary Pump SL Service Manual.

Warnings and Cautions

WARNING **To prevent personal injury, the power cable must be removed from the instrument before opening the pump cover. Do not connect the power cable to the pump while the covers are removed.**

WARNING **To prevent personal injury, be careful when getting in contact with sharp metal areas.**

WARNING **When working with solvents please observe appropriate safety procedures (for example, goggles, safety gloves and protective clothing) as described in the material handling and safety data sheet supplied by the solvent vendor, especially when toxic or hazardous solvents are used.**

CAUTION Electronic boards and components are sensitive to electrostatic discharge (ESD). In order to prevent damage always use an ESD protection when handling electronic boards and components (see "Using the ESD Strap" on page 97).

Cleaning the Binary Pump SL

The pump case should be kept clean. Cleaning should be done with a soft cloth slightly dampened with water or a solution of water and mild detergent. Do not use an excessively damp cloth as liquid may drip into the pump.

WARNING **Do not let liquid drip into the pump. It could cause shock hazard and it could damage the module.**

Using the ESD Strap

Electronic boards are sensitive to electrostatic discharge (ESD). In order to prevent damage, always use an ESD strap when handling electronic boards and components.

1 Unwrap the first two folds of the band and wrap the exposed adhesive side firmly around your wrist.

2 Unroll the rest of the band and peel the liner from the copper foil at the opposite end.

3 Attach the copper foil to a convenient and exposed electrical ground.

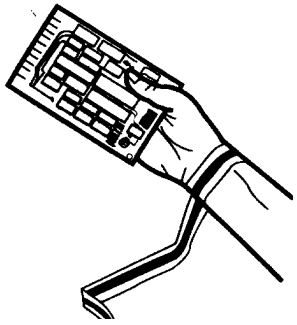


Figure 1 Using the ESD Strap

8
Maintenance and Simple Repairs

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- Installing the Active Seal Wash Option 126

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Replacing the Pump's Firmware 133

This chapter describes all maintenance and simple repair procedures that can be performed without removing the pump from the system stack.

Overview of Maintenance and Simple Repairs

Figure 2 shows the main user accessible assemblies of the Binary Pump SL. The pump heads and its parts do require normal maintenance (for example, seal exchange) and can be accessed from the front (simple repairs). Replacement of valve cartridges or filters don't require to remove the pump from the system stack.

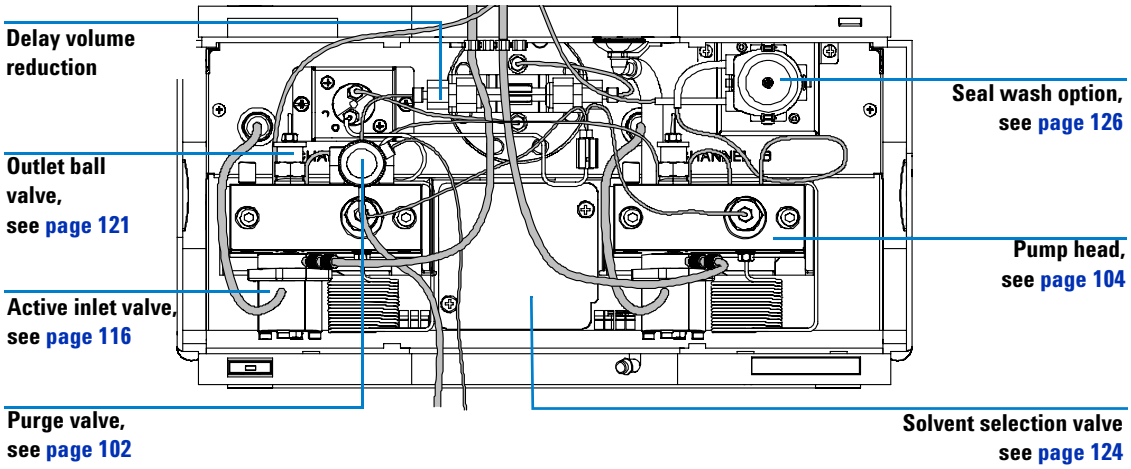

Delay volume reduction
Outlet ball valve, see page 121
Active inlet valve, see page 116
Purge valve, see page 102
Seal wash option, see page 126
Pump head, see page 104
Solvent selection valve see page 124

Figure 2 Overview of Maintenance and Simple Repair Procedures

Maintenance Procedures

The procedures described in this section can be done with the Binary Pump SL in place in the system stack.

Table 1 Maintenance Procedures

Procedure	Typical Frequency	Notes
"Exchanging the Purge Valve Frit or the Purge Valve" on page 102	Yearly, or if the frit shows indication of contamination or blockage	A pressure drop of > 10 bar across the frit (5 mL/min H_2O with purge valve open) indicates blockage
"Removing the Pump Head Assembly" on page 104as	During yearly maintenance	Necessary to get access to pump seals and plungers.
"Disassembling the pump head" on page 106	During yearly maintenance	Necessary to get access to pump seals and plungers.
"Exchanging the Pump Seals" on page 107	Yearly, or if pump performance indicates seal wear	Leaks at lower pump head side, unstable retention times, pressure ripple unstable — run pump test for verification
"Exchanging the Plungers" on page 110	If scratched or if dents are visible	Seal life time shorter than normally expected — check plungers while changing the seals
"Exchanging the Wash Seals" on page 111	Yearly	Only necessary when Seal Wash Option is installed. Leaks at lower pump head side, loss of wash solvent

Exchanging the Purge Valve Frit or the Purge Valve

When required	Frit - when plunger seals are exchanged or when contaminated or blocked (pressure drop of > 10 bar across the frit at a flow rate of 5 mL/min of H_20 with purge valve opened) Purge valve - if purge valve cannot be closed leak tight
Tools required	tools:wrench 1/4 - 5/16 inchWrench 1/4 inch Wrench 14 mm Pair of tweezers or toothpick
Parts required	PTFE Frit (pack of 5), part no. 01018-22707 Purge valve, part no. G1312-60023

1 Using a 1/4 inch wrench disconnect the pump outlet capillary at the purge valve.

2 Disconnect the waste tube. Beware of leaking solvents due to hydrostatic pressure.

3 Using the 14 mm wrench, unscrew the purge valve and remove it from the purge valve holder.

4 Remove the plastic cap with the gold seal from the purge valve.

5 Use a pair of tweezers or a toothpick to remove the frit.

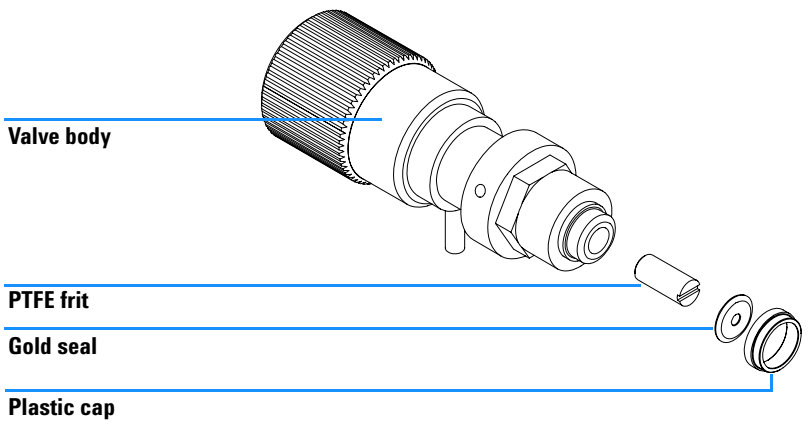


Figure 3 Purge Valve Parts

6 Place a new frit into the purge valve with the slit facing the gold seal (see Figure 3).

7 Replace the cap with the gold seal.

NOTE Before reinstallation always check the gold seal. A deformed seal or a cracked cap should be replaced.

8 Insert the purge valve into the purge valve holder and orient he waste outlet nozzle downward as shown below.

9 Tighten the purge valve and reconnect outlet capillary and waste tubing.

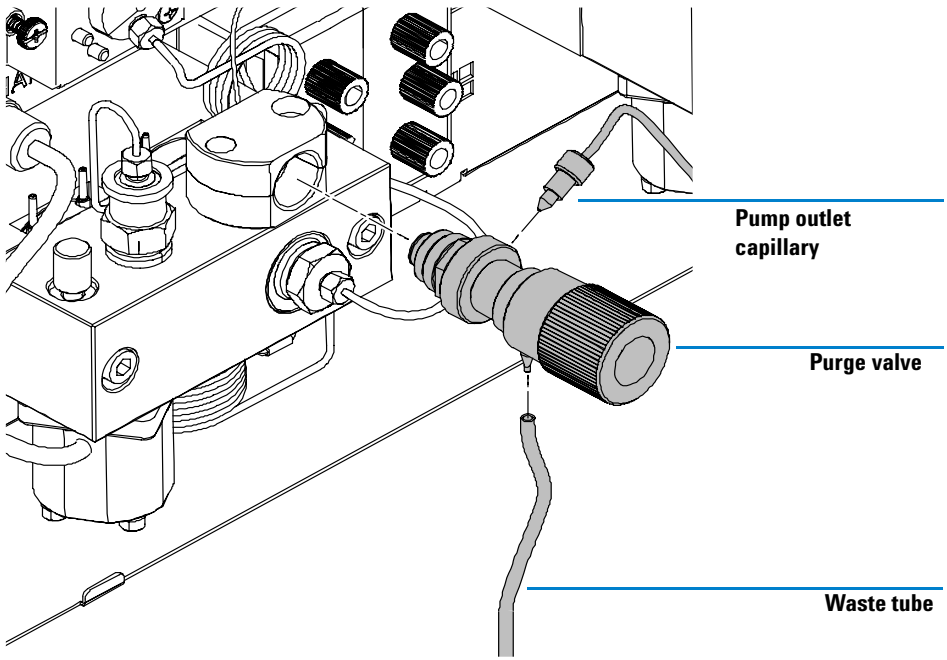


Figure 4 Exchanging the Purge Valve

Removing the Pump Head Assembly

WARNING **Never start the pump when the pump head is removed. This may damage the pump drive.**

NOTE Both pump head assemblies use the same internal components. In addition, pump head A is fitted with the purge valve. The following procedure describes the removal and disassembly of pump head A (left). For pump head B (right) proceed in the same way and skip steps that deal with the purge valve.

When required	Exchanging pump seals Exchanging plungers Exchanging seals of the seal wash option
Tools required	Wrench 1/4 inch 3-mm hexagonal key 4-mm hexagonal key 1/4 inch slitted socket wrench
Preparations for this procedure	Switch off the Binary Pump SL at power switch

1 Remove the front cover.

2 Disconnect the capillary at the pump head adapter and the tube at the active inlet valve. Beware of leaking solvents.

3 Using a 3-mm hexagonal key loosen the purge valve holder and lift it up.

4 Disconnect the active inlet valve cable.

5 Using a 4-mm hexagonal key stepwise loosen and remove the two pump head screws

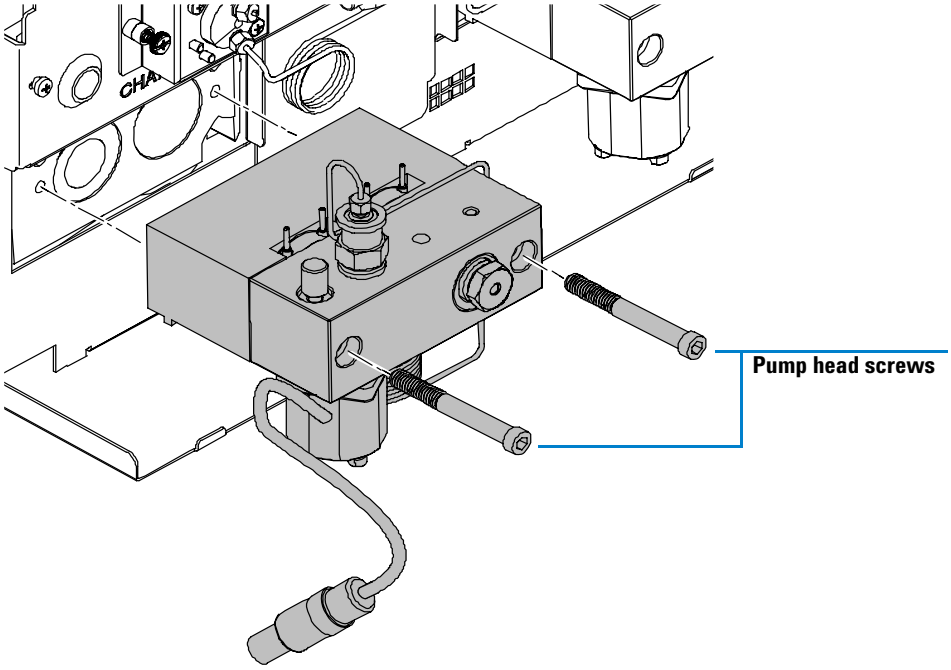
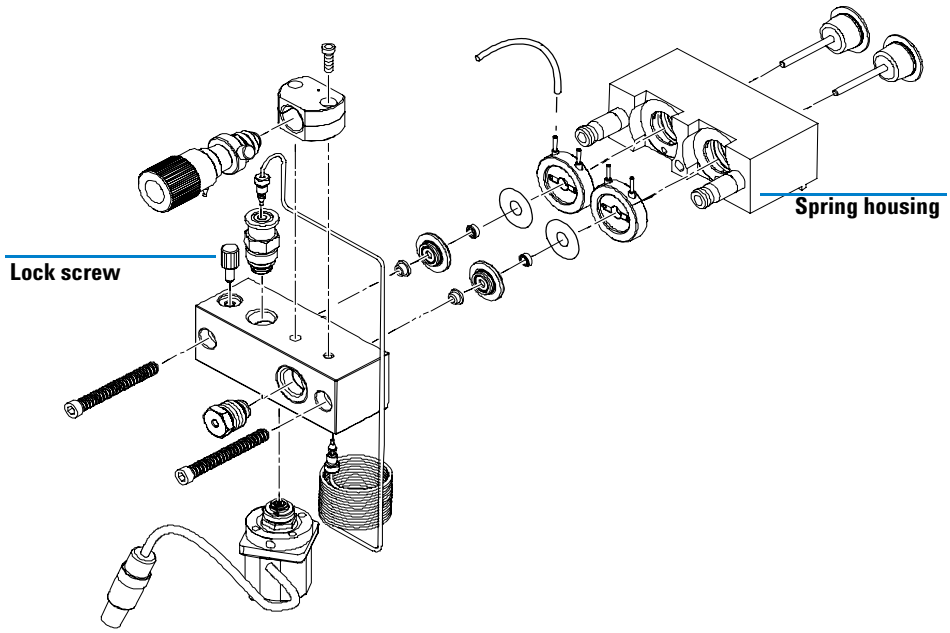


Figure 5 Removing the Pump Head

Disassembling the pump head

1. Place the pump head with the front face onto a bench.
2. Open the two hex screws on the rear side with a 3 mm hex driver.
3. Open the PEEK lock screw two to three turns.
4. Pull the spring housing up and remove it from the pump head.



Exchanging the Pump Seals

When required	Seals leaking, if indicated by the results of the pump test (check both pump heads individually!)
Tools required	3-mm hexagonal key 4-mm hexagonal key 1/4 inch wrench
Parts required	Seals (pack of 2), part no. 5065-6589 (standard) or part no. 0905-1420 (for normal phase application) For the seal wear-in procedure: Restriction capillary, part no. 5022-2159
Preparations for this procedure	Switch off Binary Pump SL at power switch Remove the front cover to have access to the pump mechanics "Removing the Pump Head Assembly" on page 104

1 Disassemble the pump head assembly, see"Disassembling the pump head" on page 106.

2 Use one of the plungers to carefully remove the seal from the pump head (be careful not to break the plunger).

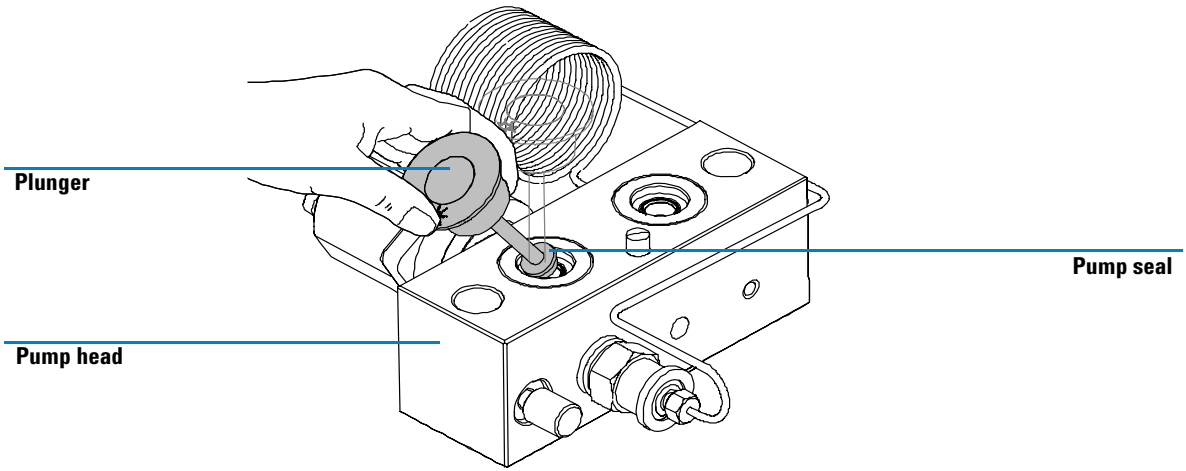


Figure 6 Removing the Pump Seals from the Pump Head

3 Insert seals into the pump head and press firmly in position.

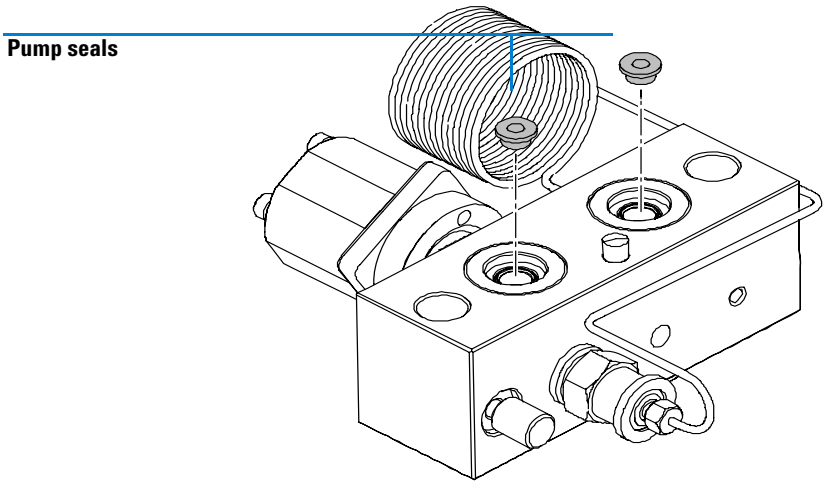


Figure 7 Inserting of new Pump Seals

4 Reassemble the pump head assembly (see "Reinstalling the Pump Head Assembly" on page 113).

NOTE Reset the seal wear counter and liquimeter with the in the Agilent LC Diagnostic software.

Seal Wear-in Procedure

NOTE This procedure is required for standard seals only (part no. 5063-6589), but it will definitely damage the normal phase application seals (part no. 0905-1420).

1. Put a bottle with 100 ml of isopropanol in the solvent cabinet and place the solvent intake filter of the pump head you want to wear in into this bottle.
2. Screw the PEEK adapter (part no. 0100-1847) onto the Active Inlet Valve and connect the inlet tube directly to it.
3. Connect the restriction capillary (part no. 5022-2159) to the purge valve. Put its other end into a waste container.
4. Open the purge valve and purge the system for 5 minutes with isopropanol at a flow rate of 2 mL/min.
5. Close the purge valve, set the flow to a value that gives a pressure of 350 bar. Pump 15 minutes at this pressure to wear the seals in. The pressure can be monitored on the analog output connector of the pump, with the Instant Pilot, Chemstation or any other controlling device connected to your pump.
6. Turn the pump **Off**, slowly open the purge valve to release the pressure from the system, disconnect the restriction capillary and reconnect the outlet capillary to the purge valve. Reconnect the intake tubing to the solvent selection valve and the connecting tube from solvent selection valve (if installed) to the AIV.
7. Purge your system with the solvent used for your next application.

Exchanging the Plungers

When required	When scratched
Tools required	3-mm hexagonal key 4-mm hexagonal key
Parts required	Plunger 5063-6586
Preparations for this procedure	Switch off Binary Pump SL at power switch Remove the front cover to have access to the pump mechanics "Removing the Pump Head Assembly" on page 104 "Disassembling the pump head" on page 106

1 Check the plunger surface and remove any deposits or layers. Most suitable is polishing of the plunger rod with toothpaste. Replace the plunger if scratched of if dents are visible.

NOTE The best way to inspect a piston is to hold it up and watch e.g. a light bulb though the piston rod. The transparent sapphire acts as a very strong magnifier and even smallest surface abnormalities become visible.

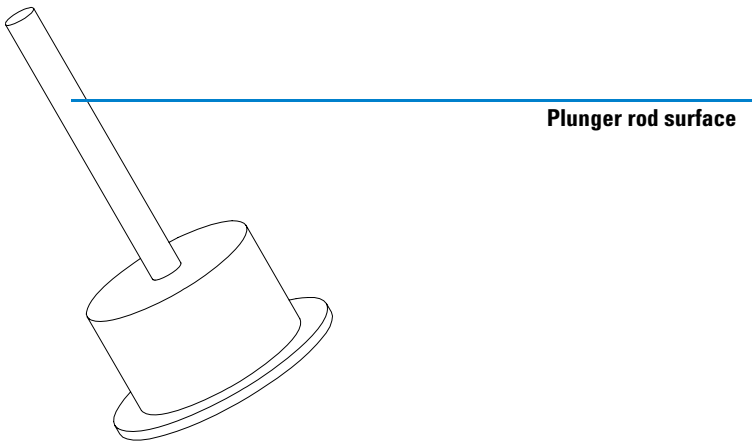
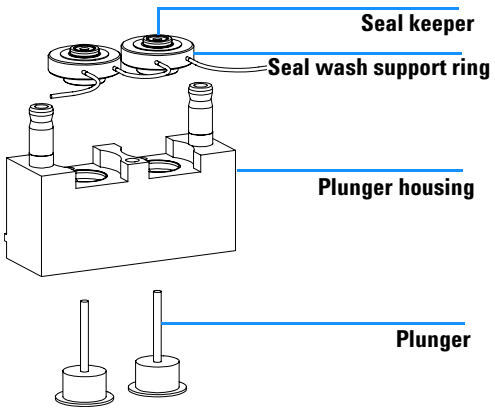


Figure 8 Plunger

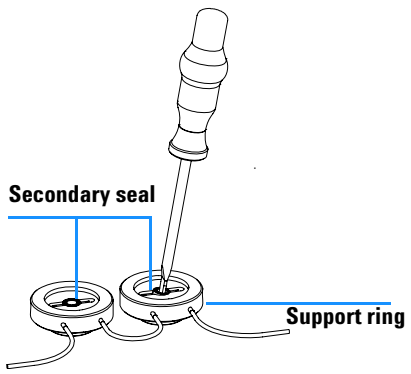
Exchanging the Wash Seals

When required	If leaking
Tools required	3-mm hexagonal key 4-mm hexagonal key Insert tool Small flat-head screwdriver
Parts required	Wash seal 0905-1175 Gasket, seal wash (pack of 6) 5062-2484
Preparations for this procedure	Switch off Binary Pump SL at power switch Remove the front cover to have access to the pump mechanics "Removing the Pump Head Assembly" on page 104 "Disassembling the pump head" on page 106

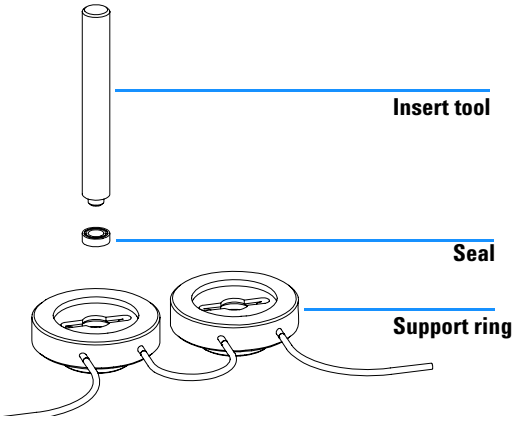
1 Remove the seal keeper and the seal wash support rings from the plunger housing. Remove the seal keeper from the support ring assembly.



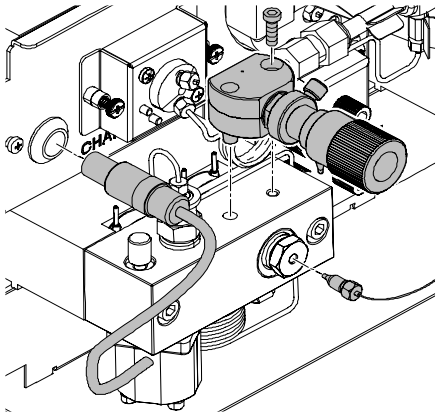
2 Using the blade of a flat head screwdriver remove seal wash gasket and the secondary seal from the support ring.



3 Using the insert tool press the seal (spring pointing upwards) into the recess of the support ring. Place a seal wash gasket in the recess of the support ring and replace the seal keeper.



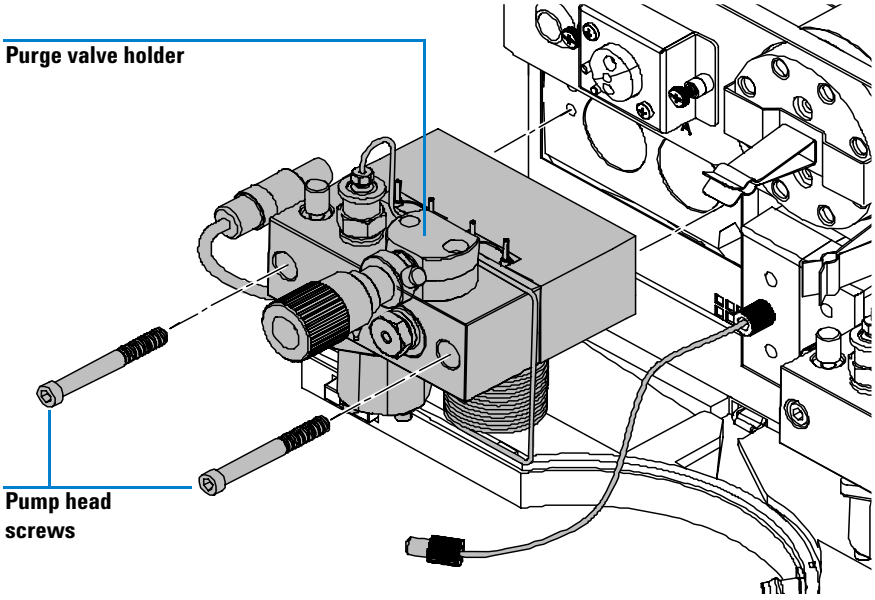
4 Reassemble the pump head assembly (see "Reinstalling the Pump Head Assembly" on page 113).



Reinstalling the Pump Head Assembly

When required	When reassembling the pump
Tools required	3-mm hexagonal key 4-mm hexagonal key
Parts required	lubricant, part no. 79841-65501

1 Slide the pump head assembly onto the pump drive.



2 Using a 4 mm hexagonal key tighten the pump head screws stepwise with increasing torque.

3 Using a 3 mm hexagonal key fix the purge valve holder to the pump head.

4 Reconnect the capillaries, tubing and the active inlet valve cable to the connector.

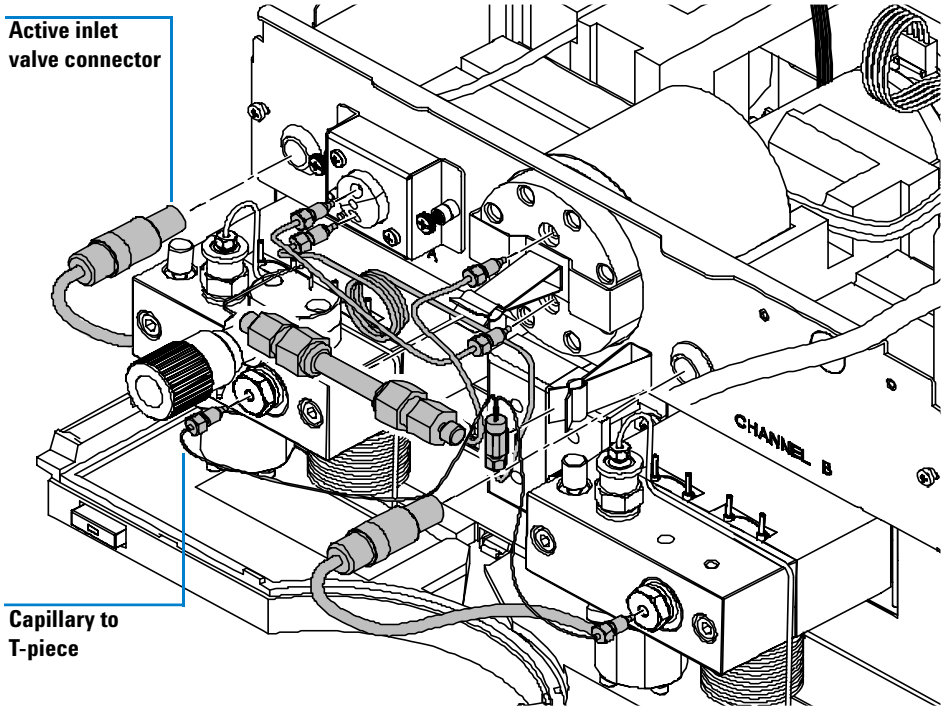


Figure 9 Reinstallation of Pump head Capillaries and AIV Connector

Simple Repair Procedures

The procedures described in this section can be done with the Binary Pump SL in place in the system stack.

Table 2 Simple Repair Procedures

Procedure	Typical Frequency	Notes
"Exchanging the Purge Valve Frit or the Purge Valve" on page 102	If internally leaking	Solvent dripping out of waste outlet when valve is closed
"Exchanging the Active Inlet Valve Cartridge" on page 116	If internally leaking	Pressure ripple unstable, run leak test for verification
"Exchanging the Active Inlet Valve Body" on page 118	If leaking externally If solenoid is defective	Error messages "Inlet Valve Fuse" or "Inlet Valve Missing"
"Exchanging the Outlet Ball Valve" on page 121	If internally leaking	Pressure ripple unstable, run leak test for verification
"Exchanging the Solvent Selection Valve" on page 124	If internally leaking If solenoid is defective	Cross port flow Error message "Valve Failed"
"Installing the Active Seal Wash Option" on page 126	When upgrading to Active Seal Wash	Recommended if buffers of > 0.1M are used regularly.

Exchanging the Active Inlet Valve Cartridge

When required	If internally leaking (backflow)
Tools required	Wrench 14 mm
Material	Cartridge for active inlet valve 600bar, part no. G1312-60020
Preparations for this procedure	Switch off Binary Pump SL at power switch

1 Remove the front cover.

2 Unplug the active inlet valve cable from the connector.

3 Disconnect the solvent inlet tube at the inlet valve (beware of leaking solvents).

NOTE Binary Pump SLs without the solvent selection valve (SSV) have an adapter installed between the solvent line and the active inlet valve (AIV). Disconnect the solvent tubes at the adapter and remove the adapter from the AIV.

4 Using a 14-mm wrench loosen the active inlet valve and remove the valve from the pump head.

5 With a pair of tweezers, remove the valve cartridge from the active inlet valve.

6 Clean the inside of the active inlet valve body. Flush the cartridge area thoroughly.

7 Push a new valve cartridge into the valve body. Make sure the valve cartridge is fully inserted.

8 Screw the valve into the pump head. Using the 14 mm wrench turn the nut until it is hand tight.

9 Position the valve so that the solvent inlet tube connection points towards the front.

10 Using the 14 mm wrench tighten the nut by turning the valve in its final position (do not overtighten the valve).

11 Reconnect the Active Inlet Valve cable to the connector in the Z-panel and the inlet tube to the valve.

12 Reinstall the front cover.

NOTE After an exchange of the valve it may be required to pump several mL of solvent before the flow stabilizes at a pressure ripple as low as it used to be when the system was still working properly.

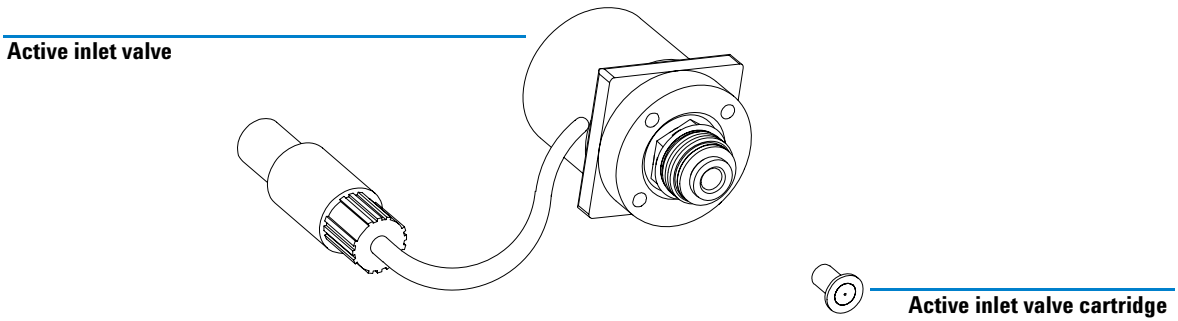


Figure 10 Replacement of the Active Inlet Valve Cartridge

Exchanging the Active Inlet Valve Body

When required	• External leak (leak sensor is activated, or • Error message "Inlet Valve Fuse" • Error message "Inlet Valve Missing"
Tools required	Wrench 14 mm
Material	Active inlet valve without cartridge, part no. G1312-60025
Preparations for this procedure	Switch off Binary Pump SL at power switch

1 Remove the front cover.

2 Unplug the active inlet valve cable from the connector.

3 Disconnect the solvent inlet tube at the inlet valve (beware of leaking solvents).

NOTE Binary Pump SLs without the solvent selection valve (SSV) have an adapter installed between the solvent line and the active inlet valve (AIV). Disconnect the solvent tubes at the adapter and remove the adapter from the AIV.

4 Using a 14-mm wrench, loosen the active inlet valve and remove the valve from pump head.

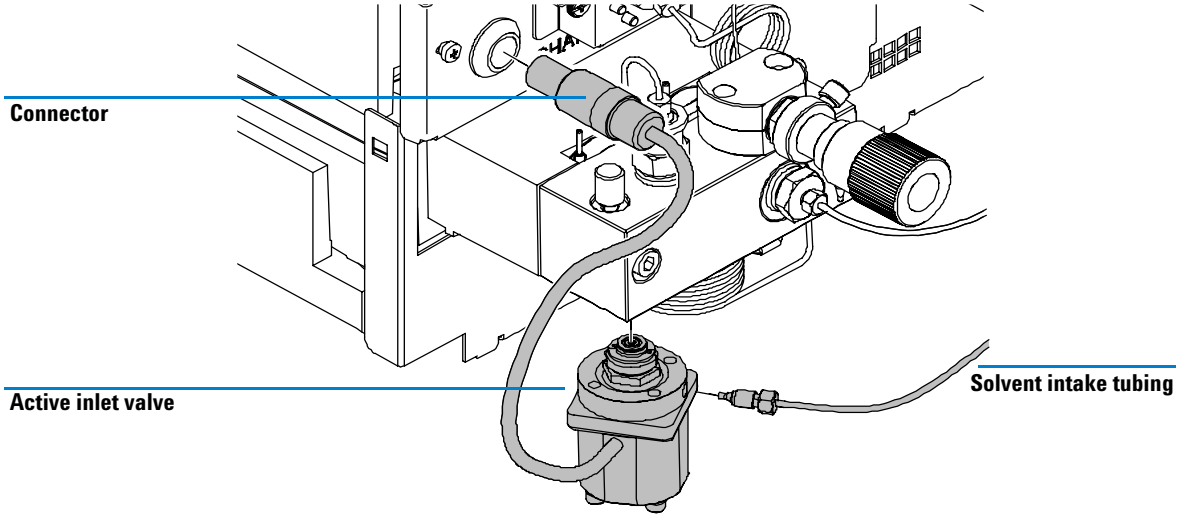


Figure 11 Removal of Active Inlet Valve

5 Using a pair of tweezers, remove the valve cartridge from the defective active inlet valve.

6 Push the cartridge into the new active inlet valve.

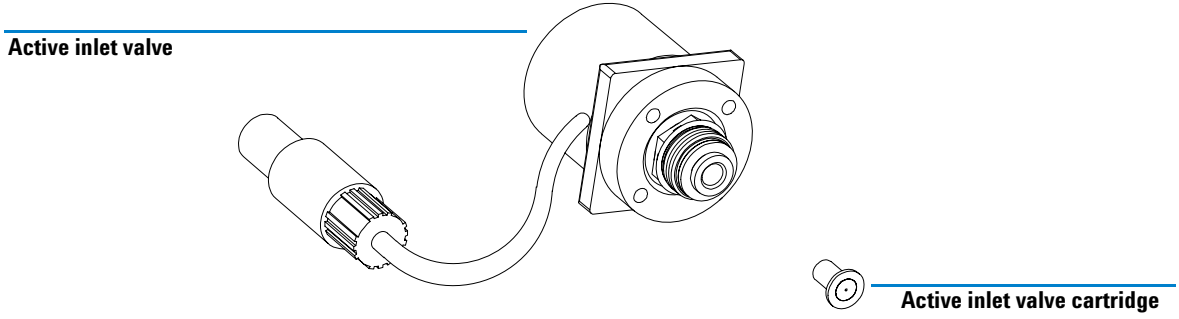


Figure 12 Replacement of the Active Inlet Valve Cartridge

7 Insert the new valve into the pump head. With the 14 mm wrench turn the nut until it is hand tight.

8 Position the valve so that the solvent inlet tube connection points towards the front.

9 Using the 14 mm wrench tighten the nut by turning the valve in its final position (not more than a quarter turn). Do not overtighten the valve.

WARNING **Overtightening the active inlet valve will destroy the active inlet valve cartridge.**

10 Reconnect the Active Inlet Valve cable to the connector in the Z-panel and the inlet tube to the valve.

11 Reinstall the front cover.

NOTE After an exchange of the valve it may be required to pump several mL of the solvent used in the current application before the flow stabilizes at a pressure ripple as low as it used to be when the system was still working properly.

Exchanging the Outlet Ball Valve

When required	if leaking internally
Tools required	tools:wrench 1/4 - 5/16 inchWrench 1/4 inch Wrench 14 mm
Parts required	Outlet ball valve G1312-60022
Preparations for this procedure	Switch off Binary Pump SL

NOTE Before exchanging the outlet ball valve you can try to clean it in an ultrasonic bath. Remove the gold seal and put the plastic cap back on to protect the sealing surface from scratches. Place the valve in upright position (sitting on the plastic cap) in a small beaker with premixed water/isopropanol (50/50). Sonicate for 5 to 10 minutes. Replace the gold seal.

1 Using a 1/4 inch wrench disconnect the valve capillary from the outlet ball valve.

2 Unscrew the valve with the 14 mm wrench and remove it from the pump body.

3 In case you are only sonicating the valve, check the plastic cap and the gold seal for damage.

NOTE Check the gold seal. It should be exchanged when heavily deformed.
Inspect the cap and replace it with a new one if cracks are visible.

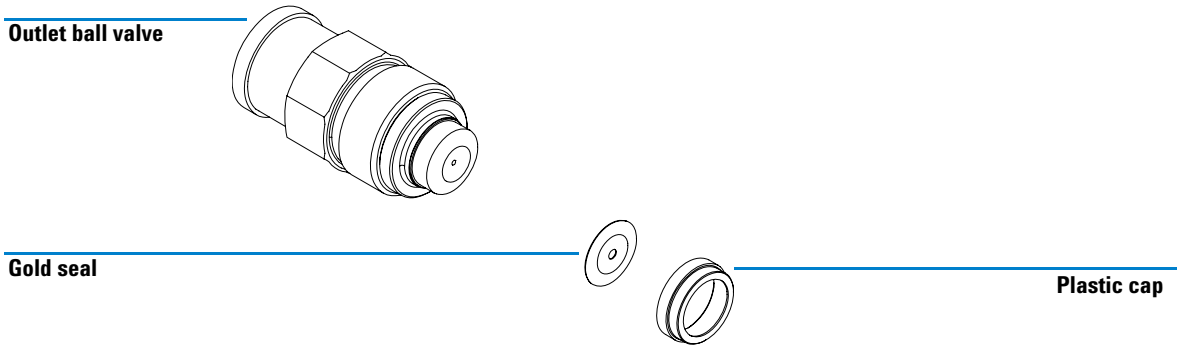


Figure 13 Outlet Ball Valve

4 Reinstall the outlet ball valve and tighten it.

5 Reconnect the valve capillary.

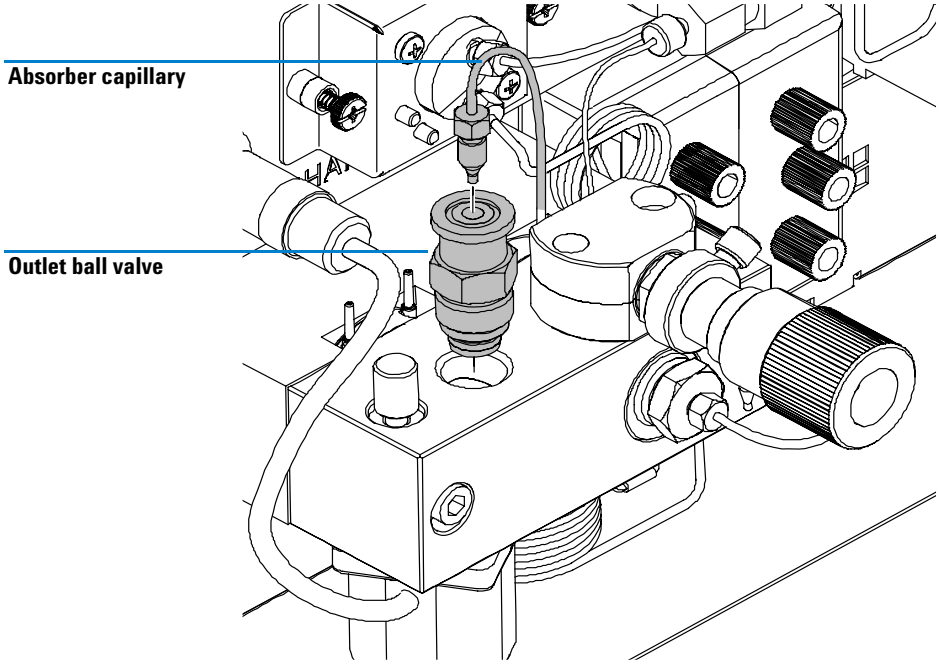


Figure 14 Outlet Ball Valve Replacement

Exchanging the Solvent Selection Valve

When required	If leaking internally (croossflow between the ports), or if one of the channels is blocked
Tools required	Screwdriver Pozidriv #1
Parts required	Solvent selection valve (PN gives half of a complete solvent selection block), part no. G1312-60000

1. Lift solvent bottle A1 out of the solvent cabinet and place it on the table. Disconnect the solvent tube from channel A1 (upper left) of the solvent selection valve and empty the tube into the bottle. Place the bottle back into the solvent cabinet.
2. Repeat step 1) for the remaining solvent channels.
3. Disconnect the active inlet valve connection tubes from the solvent selection valve.
4. Using a Pozidriv screwdriver #1 loosen the holding screws of the valves.
5. Pull the valve module out.
6. Hold the two plastic bodies of the valves and pull the two solvent selection valves apart.
7. Exchange the defective solvent selection valve. Join the new valve (new half) and the properly working old one.
8. Push the valve module into the cutout of the pump body until the electrical connectors are properly seated and fix the assembly with the two holding screws.
9. Reinstall solvent tubes and the active inlet valve connection tubes.

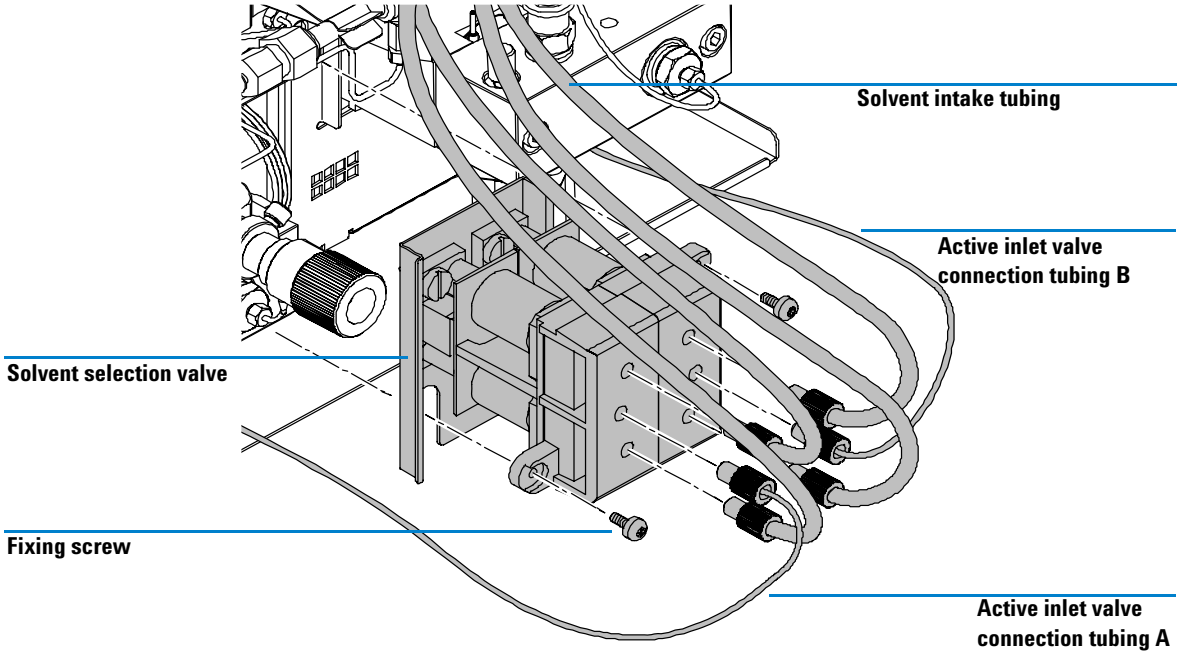

Solvent intake tubing
Active inlet valve connection tubing B
Solvent selection valve
Fixing screw
Active inlet valve connection tubing A

Figure 15 Solvent Selection Valve Replacement

Installing the Active Seal Wash Option

When required	When using concentrated buffers (> 0.1 M)
Tools required	4-mm hexagonal key Screwdriver Pozidrive #1
Parts required	Active Seal Wash Option kit for Binary Pump SL, part no. G1312-68721
Preparations for this procedure	Switch off the pump at the main power switch Remove the front cover Remove the top cover and foam

1 By using a screwdriver remove the metal plug in the z-panel.

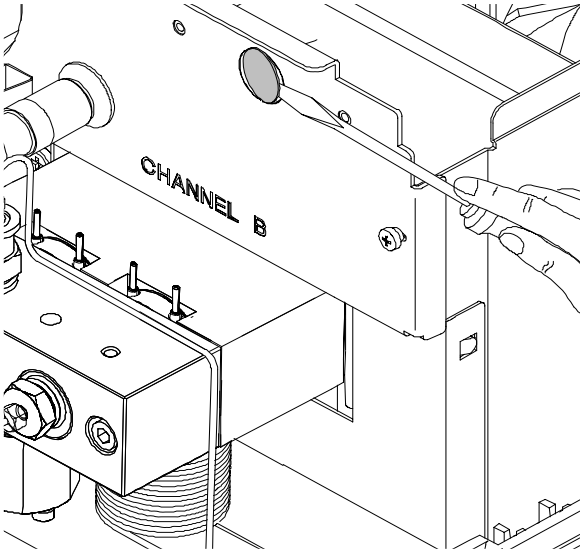


Figure 16 Removing the Metal Plug from the Z-Plane

2 Insert the socket, delivered with the Seal Wash pump assembly, into the hole on the z-panel.

3 Guide the wire of the active seal wash assembly through the hole and screw it onto the z-panel.

4 Guide the wire over the fan and plug the connector onto the mainboard connector P7.

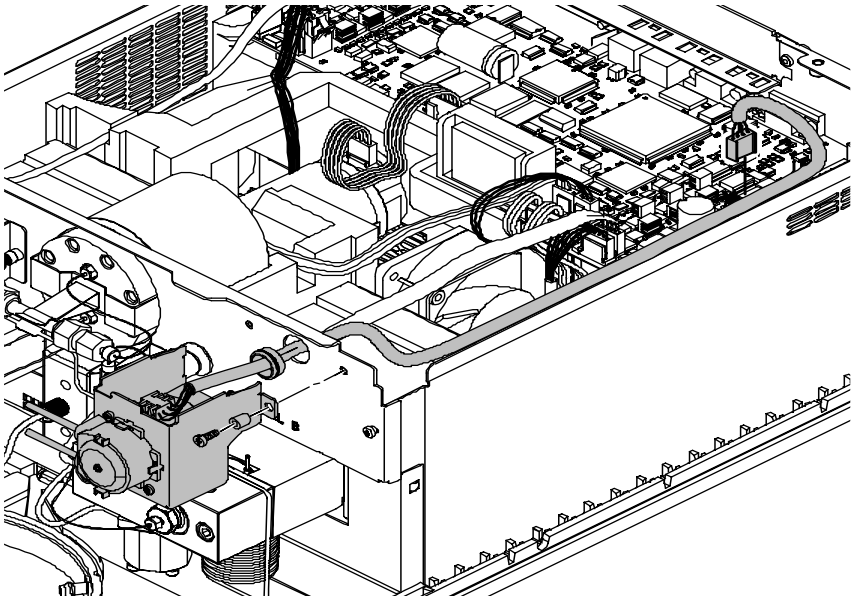


Figure 17 Mounting the Seal Wash Pump

5 Replace the foam and top cover.

6 Disconnect all capillaries and tubes from the pump head and disconnect the active inlet valve cable.

7 Using a 4-mm hexagonal key stepwise loosen and remove the two pump head screws and remove the pump head from the pump drive

8 Place the pump head on a flat surface. Loosen the lock screw (two revolutions) and while holding the lower half of the assembly carefully pull the pump head away from the plunger housing.

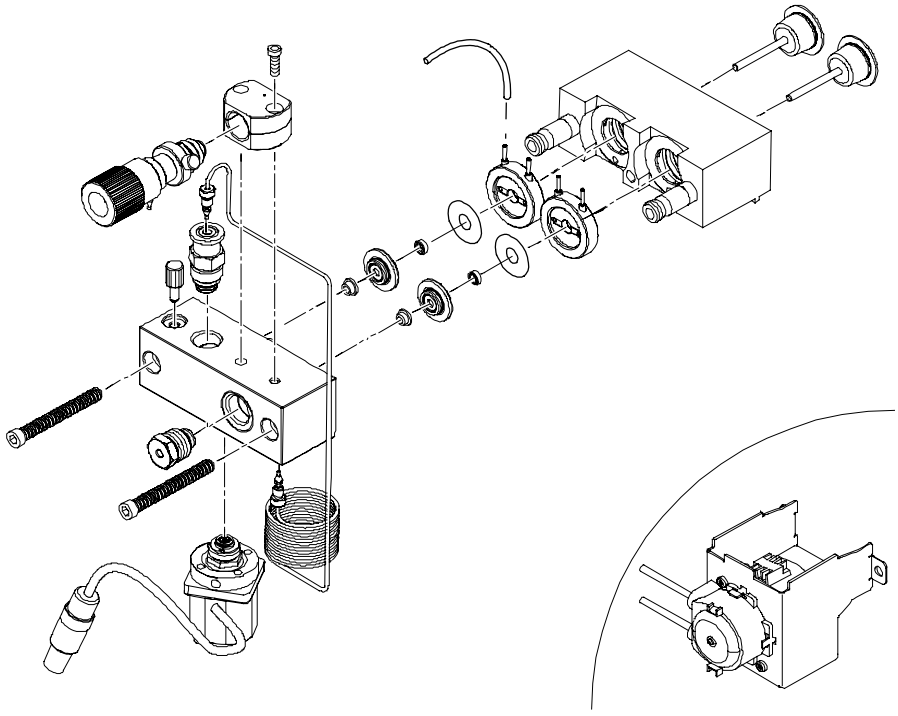


Figure 18 Exploded Diagram of the Pump Head with Seal Wash

9 Remove the support rings from the plunger housing and lift the housing away from the plungers.

10 Replace the seal wash seals and the film gaskets of the support rings.

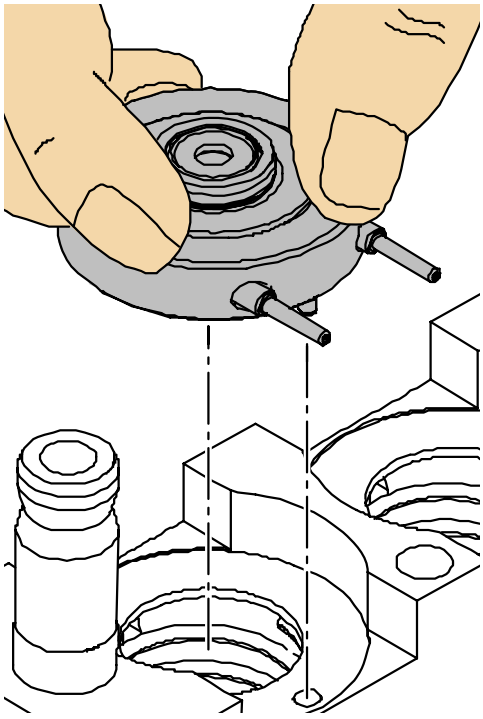


Figure 19 Inserting the active seal wash support rings.

11 Place the support rings on the plunger housing (plungers not installed) and snap the pump head and plunger housing together.

12 Insert the plungers and carefully press them into the seal.

13 Tighten the lock screw.

14 Slide the pump head assembly onto the metering drive. Apply a small amount of pump head grease (part no. 79846-65501) to the pump head

screws and the balls of the spindle drive. Tighten the pump head screws stepwise with increasing torque until they are tight.

15 Reconnect all capillaries, tubes and the active inlet valve cable to its connector

16 Route the wash tubings as shown in inlet tube into a bottle filled with a mixture of distilled water and isopropanol (90/10) and place the bottle in the solvent cabinet.

17 Route the outlet of the wash tube back into the wash solvent bottle.

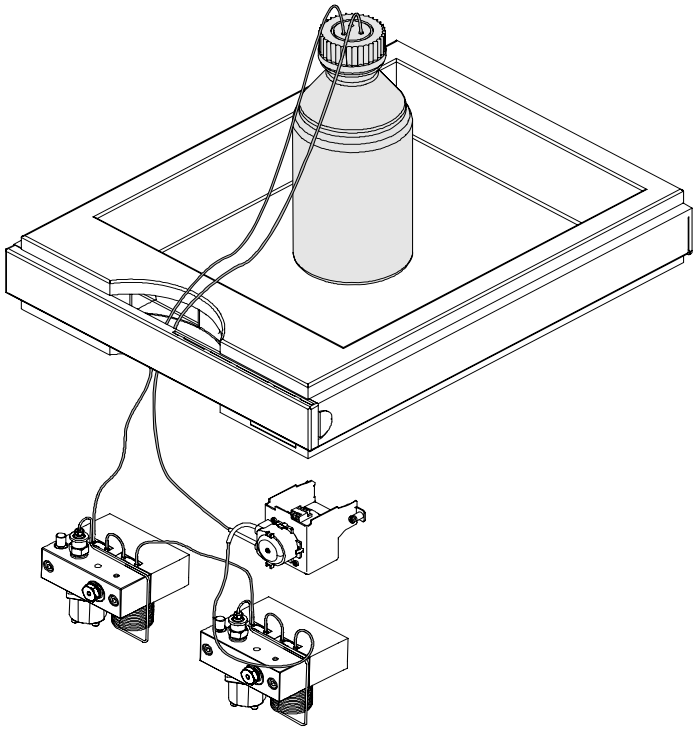


Figure 20 Routing of Active Seal Wash Tubing

Exchanging the Optional Interface Board

CAUTION The interface board is sensitive to electrostatic discharge. Always use the ESD kit when handling electronic boards.

When required	Board defective
Part required	BCD (Interface) board, see "Optional Interface Boards" on page 152

1. Switch OFF the Binary Pump SL at the main power switch. Unplug the pump from main power.
2. Disconnect cables from the interface board connectors.
3. Loosen the screws. Slide out the interface board from the Binary Pump SL.
4. Install the new interface board. Secure screws.
5. Reconnect the cables to the board connector

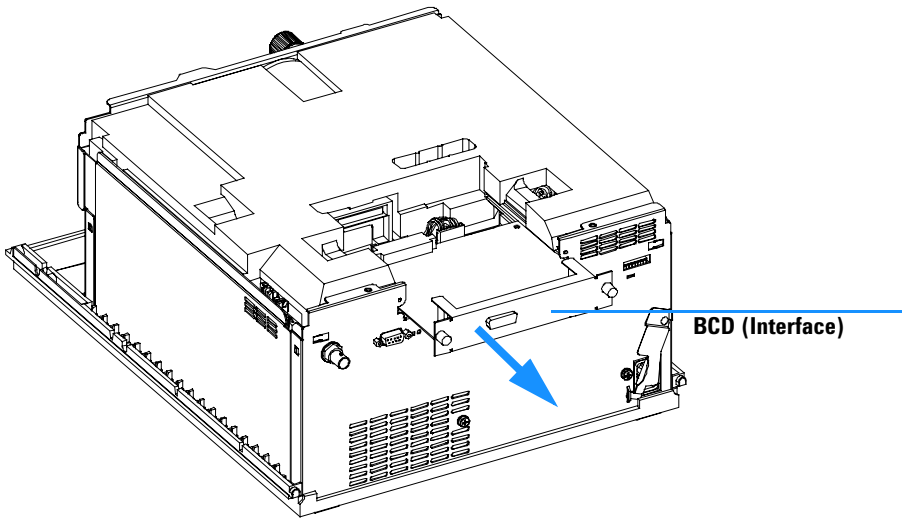


Figure 21 Exchanging the Interface Board

Replacing the Pump's Firmware

When required	If a new version resolves problems of the currently installed version or if the firmware version of a new CSM board is different from the previous one.
Tools required	LAN/RS-232 Firmware Update Tool, or Instant Pilot G4208A
Parts required	Firmware, tools and documentation from Agilent web site
Preparations	Read update documentation provided with the Firmware Update Tool.

The installation of *older* firmware might be necessary:

- to keep all systems on the same (validated) revision, or
- if third part control software requires a special version.

To upgrade/downgrade the pumps's firmware the following steps have to be performed:

1 Download the module's firmware, the LAN/RS-232 FW Update Tool version 2.1 or above and the documentation from the Agilent web site:

http://www.chem.agilent.com/scripts/cag_firmware.asp.

2 Load the firmware into the pump as described in the documentation.

NOTE The G1312B Binary Pump SL requires firmware revision A.06.02 or above (main and resident).

9 Parts and Materials for Maintenance

Bottle Head Assembly 136
Hydraulic Path with Solvent Selection Valve 138
Hydraulic Path without Solvent Selection Valve 140
Pump-Head Assembly SL 142
Outlet Ball Valve Assembly 144
Purge Valve Assembly 145
Active Inlet Valve Assembly 146
Cover Parts 147
Cover Parts 147
Active Seal Wash Option G1312-68721 149

This chapter lists all parts and tools that are required for maintenance and simple repairs.

Bottle Head Assembly

Table 3 Bottle-Head Assembly Parts

Item	Description	Part Number
1	Bottle amber, volume 1L	9301-1450
2	Bottle transparent, volume 1L	9301-1420
3	Bottle-head assembly, complete (includes 1 ea. of parts 4 - 8)	G1311-60003
4	Ferrules with lock ring	5063-6598 (10x)
5	Tube screw	5063-6599 (10x)
6	Solvent tubing, 5 m	5062-2483
7	Inlet filter adapter (pack of 4)	5062-8517
8	Solvent inlet filter, 20 µm	5041-2168

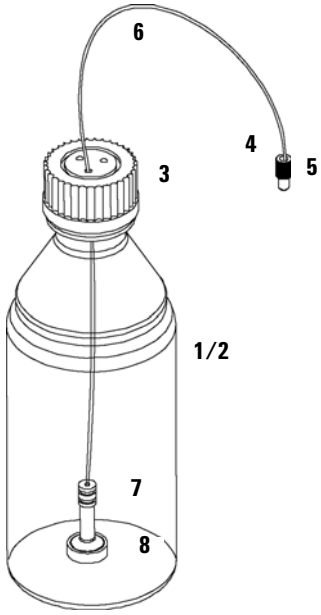


Figure 22 Bottle-Head Assembly Parts

Hydraulic Path with Solvent Selection Valve

Table 4 Hydraulic Path with Solvent Selection Valve

Item	Description	Part Number
1	Solvent tubing, (kit of 4 ea. degasser to pump SSV)	G1322-67300
2	Solvent selection valve (SSV) (PN gives half of a complete solvent selection block) Blank Plug for SSV	G1312-60000 5041-8365
3	Connecting tube (solvent selection valve to active inlet valve)	G1311-67304
	Plug for unused SSV ports (not shown)	5041-8365
4	Active inlet valve, see page 146	
5	Pump head, see page 142	
6	Outlet ball valve, see page 144	
7	Absorber capillary	G1312-87300
8	Mixing capillary	G1312-67302
9	Restriction capillary (mixing capillary to pressure sensor)	G1312-87301
10	Pressure sensor	see Service Manual
11	Capillary SSL, 0.17 x 150 mm (pressure sensor to damper)	G1312-87305
12	Damper	see Service Manual
13	Solvent mixer	G1312-87330
14	Capillary SSL, 0.17 x 105 mm (connections to solvent mixer)	G1312-87306
	Bracket for solvent mixer	G1312-04100
15	Purge valve SL, see page 145	
	Peristaltic pump cartridge (silicone tubing), not shown	5042-8507
	Tubing, 1 mm ID, 3 mm OD, silicone, 5 m, for seal wash option	5065-9978

Table 4 Hydraulic Path with Solvent Selection Valve, continued

Item	Description	Part Number
16	Capillary, pump to injector device (0.17 x 400 mm, SSL) Capillary, pump to thermostattable autosampler (0.17 x 700 mm, SSL)	G1312-87303 G1312-87304
17	Waste tube, 5 m	5062-2461

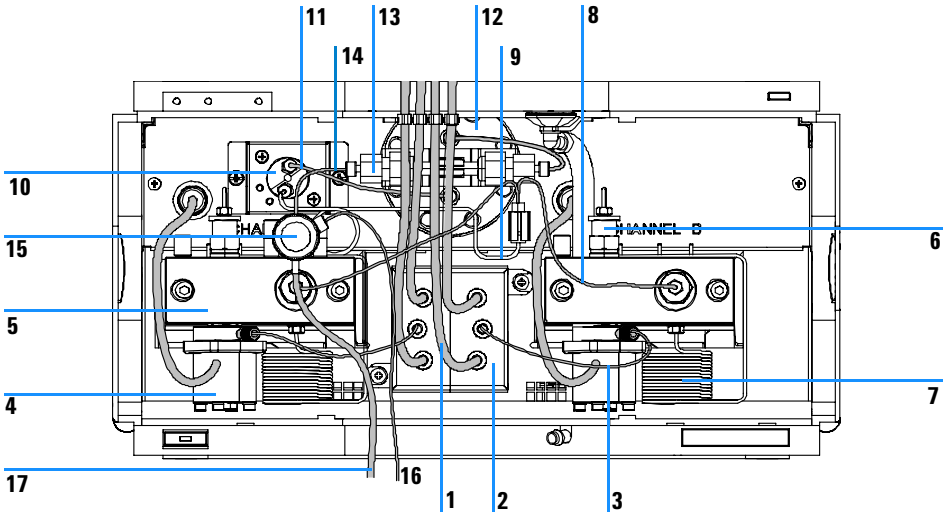


Figure 23 Hydraulic Path with Solvent Selection Valve

Hydraulic Path without Solvent Selection Valve

Table 5 Hydraulic Path without Solvent Selection Valve, With Active Seal Wash

Item	Description	Part Number
1	Solvent tubing, (kit of 4 ea. degasser to pump SSV)	G1322-67300
2	PEEK adapter 1/4-28 to 10-32	0100-1847
3	Active inlet valve, see page 146	
4	Pump head, see page 142	
5	Outlet ball valve, see page 144	
6	Absorber capillary	G1312-87300
7	Mixing capillary	G1312-67302
8	Restriction capillary (mixing capillary to pressure sensor)	G1312-87301
9	Pressure sensor	see Service Manual
10	Capillary SSL, 0.17 x 150 mm (pressure sensor to damper)	G1312-87305
11	Damper	see Service Manual
12	Solvent mixer	G1312-87330
13	Capillary SSL, 0.17 x 105 mm (connections to solvent mixer)	G1312-87306
	Bracket for solvent mixer	G1312-04100
14	Purge valve SL, see page 145	
15	Capillary, pump to injector device (0.17 x 400 mm, SSL) Capillary, pump to thermostattable autosampler (0.17 x 700 mm, SSL)	G1312-87303 G1312-87304
16	Waste tube, 5 m	5062-2461
17	Peristaltic pump (silicone tubing)	5042-8507
18	Tubing, 1 mm ID, 3 mm OD, silicone, 5 m, for seal wash option	5065-9978

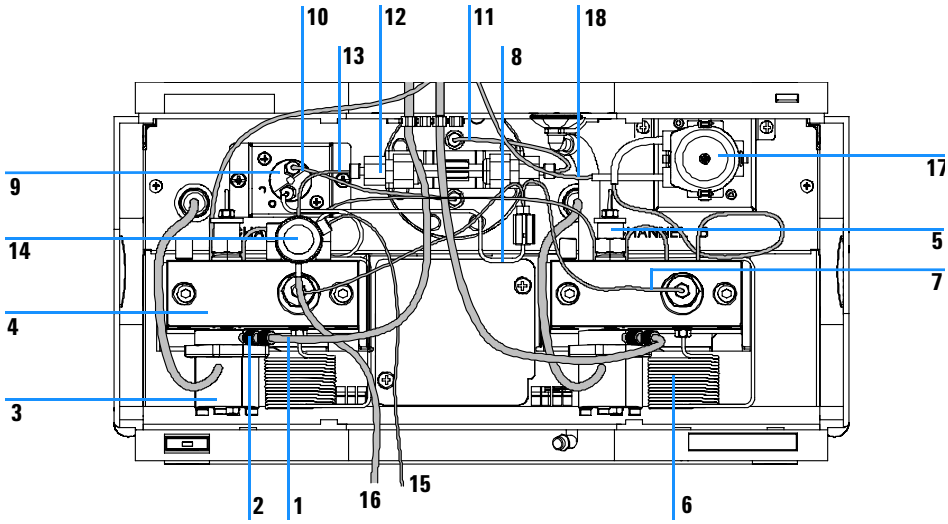


Figure 24 Hydraulic Path with Solvent Selection Valve, with Active Seal Wash

Pump-Head Assembly SL

Table 6 Pump-Head Assembly with Seal Wash

Item	Description	Part Number
	Complete assembly, included items marked with (*)	G1312-60045
1*	Sapphire piston Lubricant, black (apply to piston base)	5063-6586 79841-65501
2*	Plunger housing (including springs)	G1311-60002
3*	Support ring (includes wash seal)	5062-2465
4*	Wash seal	0905-1175
5	Tubing for seal wash option (not shown) 1 mm ID, 3 mm OD, silicone, 5 m,	5065-9978
6*	Gasket, seal wash (pack of 6)	5062-2484
7*	Seal keeper (pack of 2)	5042-8586
8*	Seal (pack of 2) **or** Seal (pack of 2), for normal phase applications (optional)	5063-6589 0905-1420
9	Absorber capillary	G1312-87300
10*	Pump chamber housing	G1311-25200
11	Active inlet valve body (without cartridge) Replacement cartridge for active inlet valve SL	G1312-60025 G1312-60020
12*	Screw, purge-valve holder	0515-0175
13	Purge-valve holder	G1312-23200
14	Outlet ball valve SL	G1312-60022
15*	Screw lock	5042-1303
16	Adapter	G1312-23201
17	Purge valve assembly SL	G1312-60023
18	Screw M5 60 mm lg	0515-2118

Table 6 Pump-Head Assembly with Seal Wash, continued

Item	Description	Part Number
19	Seal wash pump assembly (includes item 20)	5065-9953
20	Peristaltic pump (silicone tubing)	5042-8507

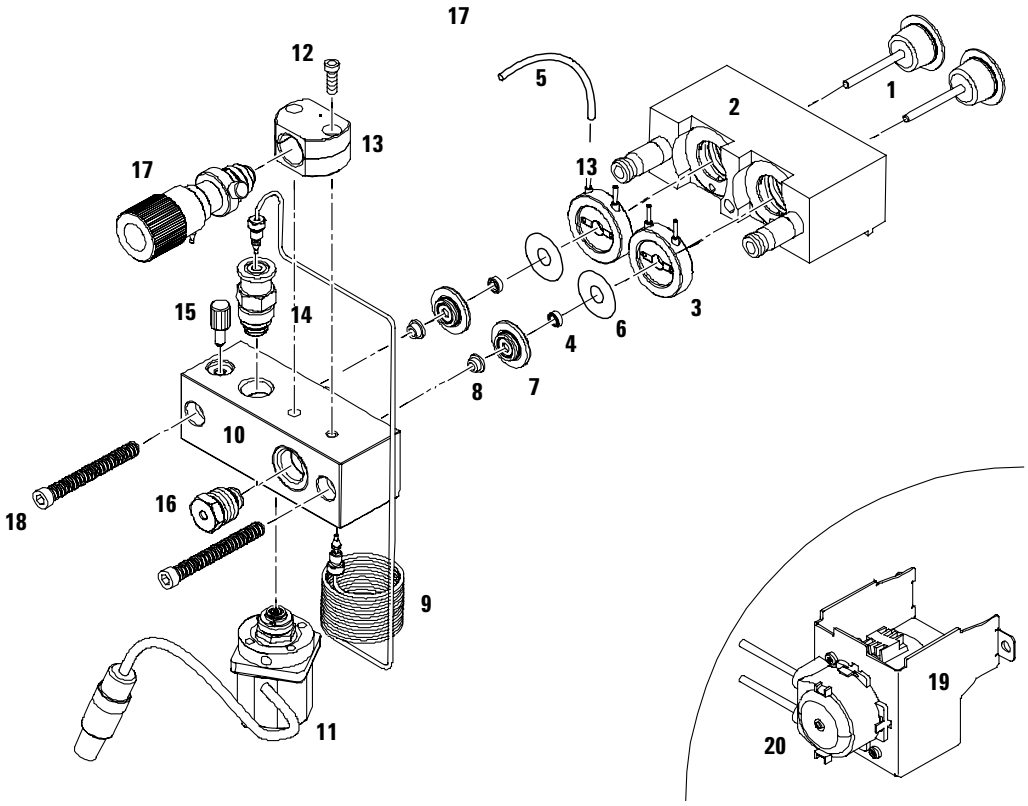
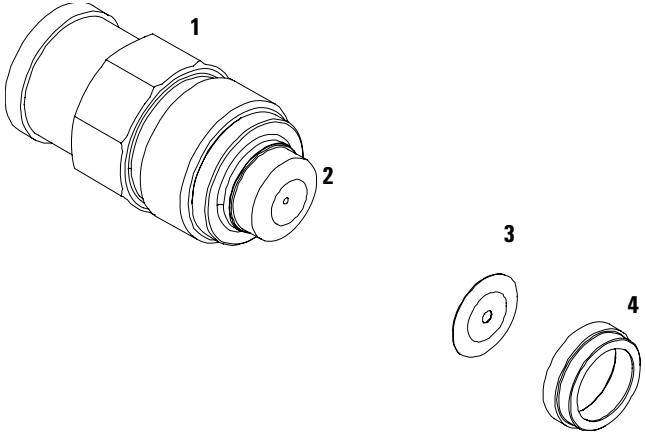


Figure 25 Pump Head Assembly with Seal Wash Option

Outlet Ball Valve Assembly

Table 7 Outlet Ball Valve Assembly

Item	Description	Part Number
	Outlet ball valve SL — complete assembly	G1312-60022
1	Housing screw	01018-22410
2	Outlet valve cartridge	No part number
3	Gold seal, outlet	5001-3707
4	Cap (pack of 4, reorder number)	5062-2485



Purge Valve Assembly

Table 8 Purge-Valve Assembly

Item	Description	Part Number
	Purge valve SL — complete assembly	G1312-60023
1	Valve body	No part number
2	PTFE frit (pack of 5)	01018-22707
3	Gold seal	5001-3707
4	Cap (pack of 4, reorder number)	5062-2485

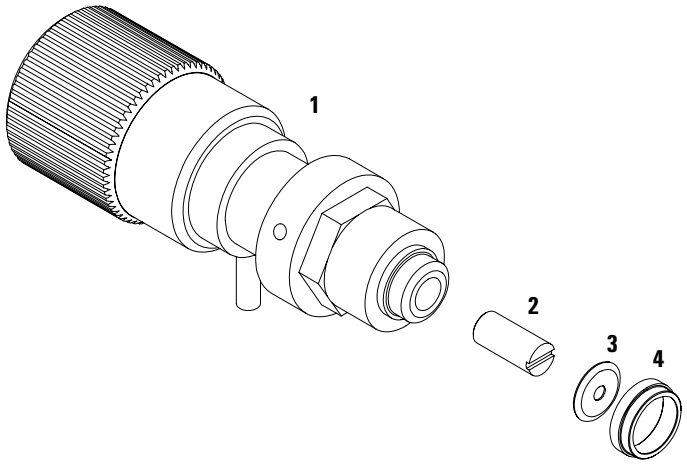


Figure 26 Purge Valve

Active Inlet Valve Assembly

Table 9 Active Inlet Valve Assembly

Item	Description	Part Number
1	Active inlet valve body	G1312-60025
2	Valve cartridge SL	G1312-60020

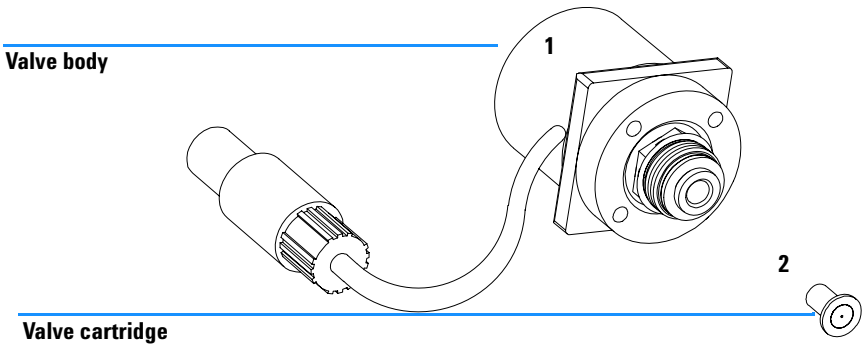


Figure 27 Active Inlet Valve Assembly

Cover Parts

Table 10 Cover Parts

Item	Description	Part Number
1	Front plate	G1312-68724

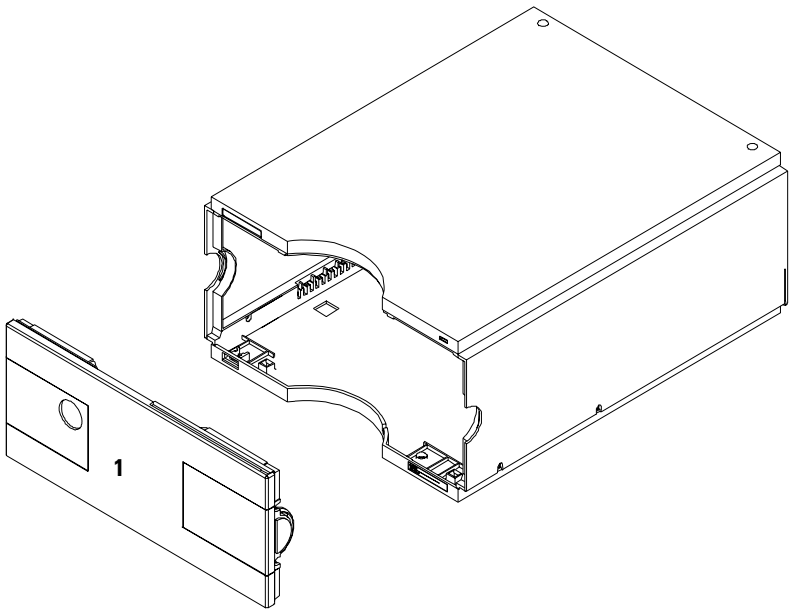


Figure 28 Cover Parts

Accessory Kit G1312-68725

Table 11 Accessory Kit G1312-68725

Description	Part Number
Insert tool for wash seals	01018-23702
PTFE Frit (pack of 5)	01018-22707
PTFE tubing, 1.45 mm ID, length 2 m, purge valve to waste PTFE tubing, 1.45 mm ID, reorder (gives 5 m)	not orderable 5062-2461
Waste tubing assembly Corrugated waste tube, reorder, (gives 5 m)	not orderable 5062-2463
Hex key 4 mm, 15 cm long T-handle	8710-2392
Wrench 1/4 – 5/16 inch	8710-0510
Hex key 3 mm, 12 cm long	8710-2411
Wrench, 14 mm	8710-1924
Hex driver open, 1/4 inch	5023-0240
CAN cable, 1 m long	5181-1519
Capillary, pump to sampler, 400 mm lg, id 0.17 mm	G1312-87303
Capillary, pump to thermostatted sampler, 700 mm lg, id 0.17 mm	G1312-87304

Active Seal Wash Option G1312-68721

Table 12 Active Seal Wash Option Kit for Binary Pump SL

Description	Part Number
Seal wash pump assembly (includes peristaltic pump and pump motor)	5065-9953
Peristaltic pump, silicone tubing	5042-8507
Secondary seal (4 ea.)	0905-1175
Gasket, wash seal (4 ea) (reorder gives pack of 6)	5062-2484
Silicone rubber tubing 1mm I.D. (3m)	0890-1764
Seal (2 packs of 2 for Binary Pump SL)	5063-6589
Seal insertion tool	01018-2370

G1316B SL Capillary System Kit

Table 13 G1316B SL Capillary System Kit G1316-68744

Item	Description	Part Number
*	Carrier for Heater or Cooling Devices, QTY=2	G1316-83200
*	High Temperature Heater (0.12 mm i.d. 1.6 µl), QTY=1	G1316-80002
*	High Temperature Heater (0.12 mm i.d. 1.6 µl), QTY=1	G1316-80003
*	Cooler (0.12 mm i.d. 1.5 µl), QTY=1	G1316-80004
	Capillary System Kit, see Table 14 for details	G1316-68716

For items * see also “Heater and Cooler Devices for G1316B” in the G1316B User Manual.

Table 14 Capillary System Kit G1316-68716

Item	Description	Part Number
	Seat Capillary 100 mm x 0.12 mm, 0.8 OD	G1367-87303
	DAD Heat Exchanger Capillary 310 mm x 0.12 mm	G1315-87339
	SS Capillary 340 mm x 0.12 mm, m/m	G1316-87319
	SS Capillary 300 mm x 0.12 mm, m/m	G1316-87318
	SS Capillary 210 mm x 0.12 mm, m/m	G1316-87317
	SS Capillary 170 mm x 0.12 mm, m/m	G1316-87316
	SS Capillary 130 mm x 0.12 mm, m/f	G1316-87315
	SS Capillary 90 mm x 0.12 mm, m/f	G1316-87314
	SS Capillary 70 mm x 0.12 mm, m/f	G1316-87313
	SS Capillary 50 mm x 0.12 mm, m/f	G1316-87312
	SS Capillary 170 mm x 0.12 mm, m/f	G1316-87327

Table 14 Capillary System Kit G1316-68716, continued

Item	Description	Part Number
	SS Capillary 500 mm x 0.12 mm, m/m	G1316-87309
	SS Capillary 500 mm x 0.12 mm, m/m	G1315-87307

Optional Interface Boards

The Agilent 1200 Series modules have one optional board slot that allows to add an interface board to the modules.

Table 15 Optional Interface Boards

Description	Part Number
BCD Board	G1351-68701
Fuse 250 mA (four are on the board	2110-0004
LAN Communication Interface Board	G1369A or G1369-60001

A
Appendix

General Safety Information 154
Lithium Batteries Information 157
Radio Interference 158
Sound Emission 159
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This appendix provides general safety and environmental information.

General Safety Information

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Agilent Technologies assumes no liability for the customer's failure to comply with these requirements.

General

This is a Safety Class I instrument (provided with terminal for protective earthing) and has been manufactured and tested according to international safety standards.

The Agilent 1200 modules are designed and certified as a general purpose laboratory instrument for research and routine application only. It is not certified for in-vitro or medical applications.

Operation

Before applying power, comply with the installation section. Additionally the following must be observed.

Do not remove instrument covers when operating. Before the instrument is switched on, all protective earth terminals, extension cords, auto-transformers, and devices connected to it must be connected to a protective earth via a ground socket. Any interruption of the protective earth grounding will cause a potential shock hazard that could result in serious personal injury. Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any intended operation.

Make sure that only fuses with the required rated current and of the specified type (normal blow, time delay, and so on) are used for replacement. The use of repaired fuses and the short-circuiting of fuseholders must be avoided.

CAUTION The operator of this instrument is advised that if the equipment is used in a manner not specified in this manual, the protection provided by the equipment may be impaired.

Some adjustments described in the manual, are made with power supplied to the instrument, and protective covers removed. Energy available at many points may, if contacted, result in personal injury.

Any adjustment, maintenance, and repair of the opened instrument under voltage should be avoided as much as possible. When inevitable, this should be carried out by a skilled person who is aware of the hazard involved. Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present. Do not replace components with power cable connected.

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

Do not install substitute parts or make any unauthorized modification to the instrument.

Capacitors inside the instrument may still be charged, even though the instrument has been disconnected from its source of supply. Dangerous voltages, capable of causing serious personal injury, are present in this instrument. Use extreme caution when handling, testing and adjusting.

When working with solvents please observe appropriate safety procedures (e.g. goggles, safety gloves and protective clothing) as described in the material handling and safety data sheet by the solvent vendor, especially when toxic or hazardous solvents are used.

Safety Symbols

Table 16 shows safety symbols used on the instrument and in the manuals.

Table 16 Safety Symbols

Symbol	Description
	The apparatus is marked with this symbol when the user should refer to the instruction manual in order to protect the apparatus against damage.
	Indicates dangerous voltages.
	Indicates a protected ground terminal.

WARNING **A warning alerts you to situations that could cause physical injury or damage to the equipment. Do not proceed beyond a warning until you have fully understood and met the indicated conditions.**

CAUTION A caution alerts you to situations that could cause a possible loss of data. Do not proceed beyond a caution until you have fully understood and met the indicated conditions.

Lithium Batteries Information

WARNING **Danger of explosion if battery is incorrectly replaced. Replace only with the same or equivalent type recommended by the equipment manufacturer. Lithium batteries may not be disposed-off into the domestic waste.**

Transportation of discharged Lithium batteries through carriers regulated by IATA/ICAO, ADR, RID, IMDG is not allowed. Discharged Lithium batteries shall be disposed off locally according to national waste disposal regulations for batteries.

WARNING **Lithiumbatteri - Eksplosionsfare ved fejlagtig håndtering. Udskiftning må kun ske med batteri af samme fabrikat og type. Lever det brugte batteri tilbage til leverandøren.**

WARNING **Lithiumbatteri - Eksplosionsfare. Ved udskiftning benyttes kun batteri som anbefalt av apparatfabrikanten. Brukt batteri returneres appararleverandoren.**

NOTE Bij dit apparaat zijn batterijen geleverd. Wanneer deze leeg zijn, moet u ze niet weggooien maar inleveren als KCA.

Radio Interference

Never use cables other than the ones supplied by Agilent Technologies to ensure proper functionality and compliance with safety or EMC regulations.

Test and Measurement

If test and measurement equipment is operated with equipment unscreened cables and/or used for measurements on open set-ups, the user has to assure that under operating conditions the radio interference limits are still met within the premises.

Sound Emission

Manufacturer's Declaration

This statement is provided to comply with the requirements of the German Sound Emission Directive of 18 January 1991.

This product has a sound pressure emission (at the operator position) < 70 dB.

- Sound Pressure Lp < 70 dB (A)
- At Operator Position
- Normal Operation
- According to ISO 7779:1988/EN 27779/1991 (Type Test)

Solvent Information

Observe the following recommendations on the use of solvents.

Flow Cell

Avoid the use of alkaline solutions (pH > 9.5) which can attack quartz and thus impair the optical properties of the flow cell.

If the flow cell is transported while temperatures are below 5 degree C, it must be assured that the cell is filled with alcohol.

Aqueous solvents in the flow cell can built up algae. Therefore do not leave aqueous solvents sitting in the flow cell. Add small % of organic solvents (e.g. acetonitrile or methanol ~5%).

Solvents

Brown glass ware can avoid growth of algae.

Always filter solvents through 0.4 µm filters, small particles can permanently block the capillaries and valves. Avoid the use of the following steel-corrosive solvents:

- Solutions of alkali halides and their respective acids (for example, lithium iodide, potassium chloride, and so on).
- High concentrations of inorganic acids like sulfuric acid and nitric acid, especially at higher temperatures (replace, if your chromatography method allows, by phosphoric acid or phosphate buffer which are less corrosive against stainless steel).
- Halogenated solvents or mixtures which form radicals and/or acids, for example:

  $2CHCl_3 + O_2 \rightarrow 2COCl_2 + 2HCl$

  This reaction, in which stainless steel probably acts as a catalyst, occurs quickly with dried chloroform if the drying process removes the stabilizing alcohol.

- Chromatographic grade ethers, which can contain peroxides (for example, THF, dioxane, di-isopropylether) such ethers should be filtered through dry aluminium oxide which adsorbs the peroxides.
- Solvents containing strong complexing agents (e.g. EDTA).
- Mixtures of carbon tetrachloride with 2-propanol or THF.

Agilent Technologies on the Internet

For the latest information on products and services visit our worldwide web site on the Internet at:

http://www.agilent.com

Select “**Products**” - “**Chemical Analysis**”

It will also provide the latest firmware of the Agilent 1200 series modules for download.

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In This Book

This manual contains user information about the Agilent 1200 Series Binary Pump SL. The manual describes the following:

- introduction to the pump
- installation,
- optimizing performance,
- diagnostics and troubleshooting,
- maintenance and easy repairs,
- parts and materials,
- specifications.

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